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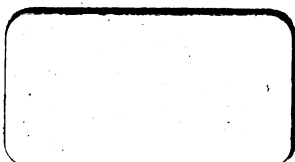
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Soil Survey in Cooperation with the College of Agriculture

H. L. RUSSELL, Dean

Bulletin No. XLVII

Soil Series No. 12

RECONNOISSANCE SOIL SURVEY

OF

WISCONSIN

The Reconnaissance Soil Survey Map and Report covering Marinette County, which were prepared by Dr. Samuel Weidman of the Wisconsin Geological and Natural History Survey, and Percy O. Wood of the U. S. Department of Agriculture in 1909 and published by the Wisconsin Geological and Natural History Survey as Bulletin XXIV, Soil Series No. 1, were used in the preparation of the soil map and report of the Reconnaissance Soil Survey of North Eastern Wisconsin. No additional field work was done in Marinette County but after inspection the various types were correlated with the soils in the adjoining counties.

MILTON WHITNEY, CHIEF.

CURTIS F. MARBUT, IN CHARGE SOIL SURVEY.

MADISON, WISCONSIN

PUBLISHED BY THE STATE.

1916

Wisconsin Geological and Natural History Survey

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MAP.

SOIL MAP OF NORTHEASTERN WISCONSIN—Attached to back cover.

NOTE

The soil survey of Wisconsin is being made along two lines; first, a general survey of the northern and less developed portions of the state, and second a detailed survey by counties of the southern and older portions. The northern part of the State has been divided into five areas of each of which a general map of the soils is being prepared.

The first area surveyed included Portage, Wood, Clark, Taylor, Lincoln, Marathon, and portions of Price and Langlade Counties. The first survey of the soils of this area was made a number of years ago by Doctor Samuel Weidman in connection with the geological survey, and the classification followed in this work differed somewhat from that at present in use, and the maps do not show as much detail. The reports on this survey are no longer available. However, the field work of an entirely new survey of the soils of Portage, Wood, Clark, Taylor, Marathon, and Lincoln Counties has been completed and it is hoped that the report and new map of the soils of these counties will be ready for distribution early in the year 1917.

The second area, called the South Part of North Western Wisconsin, included Polk, Barron, most of Rusk, and all of Chippewa, Dunn, St. Croix, Pierce, Pepin, and Eau Claire Counties. The edition of this report has been exhausted.

The third area, called the North Part of North Western Wisconsin, included Burnett, Washburn, Sawyer, Douglas, and Bayfield counties, and most of Ashland County. The report on this area is now available.

A special report has been prepared on the northeastern portion of Bayfield County along the bay and including the islands, in which considerable development of the fruit industry is taking place. This is now available for distribution.

The fourth area, covered by the present report, includes Florence, Forest, Langlade, Oconto, Marinette, and Shawano Counties. The survey of Marinette County was made during the summer of 1909 by Doctor Samuel Weidman of the Wisconsin Geological & Natural History Survey and Percy O. Wood of the United States Department of Agriculture, and a special report was issued on this county, but is no longer available for distribution; however, the map and all essential parts of the report are included in the present report.

The field work of the fifth area, called the North Part of North Central Wisconsin, including Iron, Vilas, Price, and Oneida Counties and the eastern portions of Ashland and Rusk Counties, has been completed and it is hoped that the report will be ready for distribution in the fall of 1916. A special report on the soils of Vilas County and portions of adjoining counties was prepared during the season of 1914 at the request of the Legislature when that body was considering the extent to which the development of forest reserve should be carried. Mr. T. J. Dunnewald was in charge of the field work of this survey. The map accompanying this report is included in the report on the soils of the North Part of North Central Wisconsin as well as the more important portions of the report itself, but copies of the special report and map are still available.

RECONNOISSANCE SOIL SURVEY OF NORTH EASTERN WISCONSIN

CHAPTER I

GENERAL DESCRIPTION AND HISTORY OF THE AREA

Location and Boundaries.—The area covered by the Reconnaissance Soil Survey of North Eastern Wisconsin includes Forest, Florence, Marinette, Oconto, Langlade, and Shawano Counties, and comprises a total area of approximately 6,098 square miles, or 3,902,720 acres.

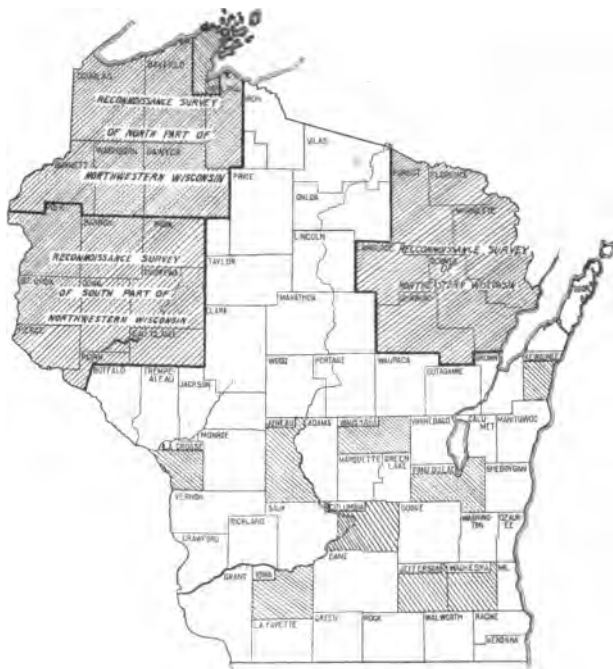


Fig. 1. Showing areas which have been surveyed in Wisconsin.

Topographic Features.—The surface features are characteristic of a glaciated region and the topography varies from level to rolling and hilly. Ridges in the form of terminal and recessional moraines frequently alternate with less broken tracts of ground moraine, with basins, extensive outwash plains, and numerous swamps and lakes,

all having a general northeast and southwest direction. In some places the glacial drift covering has completely obliterated the topographic features of the underlying rock formation, while in other places it only modifies the older topography. While there is some broken land in the area, and numerous hills with steep slopes, the proportion of land which is too rough to be developed agriculturally is comparatively small.

The northwestern portion of this area forms a part of the high plateau-like region of northern Wisconsin, and is dotted with lakes and swamps which are the source of a large number of rivers. The swamps and lakes of this plateau have an average elevation of about 1600 feet. The lowest land has an elevation of about 585 to 590 feet. Thus it will be seen that there is a difference between the highest and the lowest points within the area of something over 1000 feet.

*Water power.**—The rivers of the area have wonderful possibilities for the development of water power, and a number of projects have been installed, but only a very small proportion of the available power has been developed. From the north line of Langlade County where the Wolf River crosses to Shawano, a distance of about 80 miles, there is a fall of 774 feet. The Oconto River through its course of 87 miles, all of which is within the area, has a total fall of 945 feet. All of the numerous streams which have their source in the high plateau-like crystalline rock region of northern Wisconsin, and reach their outlet within a comparatively short distance, must necessarily have a very rapid descent.

Settlement.—The first permanent settlers were attracted to this region by the lumber industry. The first saw mill was located at Marinette in 1832. A settlement was started at Pensaukee in Oconto County in 1829 and a saw mill was erected in Oconto in 1835 and 1836. A mill was put in operation at Oconto Falls in 1846. Antigo was founded in 1877 and platted in 1879. As early as 1871 there was a settlement established on the Military Road in eastern Langlade County and in 1876 and 77 a settlement was also established at Phlox.

In 1882, a railroad line reached Antigo and in 1881 what is now the Chicago, Milwaukee, and St. Paul Railroad was completed across the area from north to south. Since that time a number of other lines have been completed, all of which have greatly assisted in the development and settlement of the region.

The first farming operations in the area were begun about 1870, but agriculture was an unimportant industry until in the eighties.

See Wis. Geological Survey Bul. XXXV.

The southeastern parts of Marinette, Oconto, and Shawano Counties, and the country about Antigo, in Langlade County, were first settled and are now the most extensive and highly developed portions of the region surveyed.

Probably half of the early settlers were native born Americans from the southern part of the state and from other states. A large proportion of the foreign born element was from Canada, of English and French extraction. The most important sources of immigration from Europe before 1885 were Germany, Sweden, Norway, Great Britain, and Ireland. Later the Polish became an important element. Bohemia, Austria, France, Denmark, and Holland, are also represented. The greater proportion of the present population consists of native born Americans. Native born Germans are probably second in numbers, with Scandinavians third. The population of the entire area for 1910 was 118,578, or at the rate of about 19 per square mile. The southern portion, and southeastern portions of the area are well settled and many communities have as large a population per square mile as the highly developed farming communities of southern Wisconsin. Forest and Florence Counties have on the average about 6 people per square mile. Between these two extremes, all degrees of settlement and improvement are found within the present survey.

Transportation Facilities.—Excellent transportation facilities are afforded nearly every portion of the survey that is developed, and railroad lines lead into many of the undeveloped regions where lumbering is being carried on. In addition to these lines there are a number of logging roads, which also carry freight and passengers, which are not permanent. From the southern boundary of the area to Green Bay it is but 12 miles, to Milwaukee 126 miles, and 311 miles to Chicago over the Northwestern Railway.

Markets.—The cities, towns, and lumbering camps within the area surveyed afford a market for a large amount of farm produce. Green Bay, Milwaukee, and Chicago also provide a ready market for all classes of produce. The extensive lumbering interests in this portion of Wisconsin and in northern Michigan, together with the iron and copper mining districts consume large amounts of food stuffs and in addition to freight charges, Chicago prices are usually paid.

Public Roads and Schools.—Throughout the southern and southeastern portions of the area there are public roads on most of the section lines. Many of these are graded and some are crowned with gravel and are well improved. In the northern part of the survey, which is thinly settled, there are not many public roads. The

wagon roads between the chief towns are usually in fair condition, but the side roads are often in poor repair. A number of roads are now being improved under the new State Highway Law, through which the state co-operates with the county and township.

Rural free delivery mail routes have been established in nearly all portions of the region and by far the greater proportion of the families in this region have their mail delivered daily. The rural telephone is also in common use.

The rural school buildings throughout this region are in many cases superior to those in the southern part of the state. In a number of instances where the attendance was small several districts have been consolidated, and the children are carried to and from school in public conveyances.

Underlying Rocks.—The soils of this region were formed by the action of the ice during glacial periods on the residual soils originally existing, and which had previously been formed by weathering from the underlying rocks. The underlying rocks of this part of the State are granite and other crystalline varieties in the larger portion of the area covering Florence, Forest, Langlade, and the northwestern portions of Marinette, Oconto, and Shawano Counties.

Along the southeastern side of this area there is a broad belt of sedimentary rocks the lower member of which is the Potsdam sandstone resting on the granitic formation and having a dip to the southeastward. Lapping on the Potsdam come successively the Lower Magnesian limestone, St. Peters sandstone, and Trenton limestone, the outcrops of which extend northeastward and southwestward and have a width depending on the thickness of the strata. The bulk of the subsoil now existing was derived by weathering from these rocks, but has been reworked and carried from one section to another somewhat by the glacial ice of the Labrador Glacier.

In the northern parts of Florence and Forest Counties considerable sandy material is now found which was brought from sandstone rock across the border in northern Michigan. Associated with the till soils are considerable areas of overwash plains and valley trains, varying in texture from that of fine silt loam to coarse sands.

Ten soil series and twenty-five types, excluding Peat and Muck, have been mapped.

The following table gives the names and the actual and relative extent of each of the soils mapped in this survey:

AREAS OF DIFFERENT SOILS

Soil	Acres	Per cent	Soil	Acres	Per cent
Kennan silt loam.....	738,432	22.9	Coloma fine sandy loam	46,656	1.2
Rolling phase.....	156,672				
Kennan fine sandy loam.....	428,544	10.9	Superior fine sandy loam.....	27,072	.7
Peat.....	380,736	9.8			
Vilas sandy loam.....	316,224	8.1	Plainfield sandy loam..	14,976	.4
Vilas fine sand.....	294,336	7.5	Vilas sand.....	10,368	.3
Miami fine sandy loam	275,904	7.4	Poygan fine sandy loam.....	9,856	.3
Poorly drained phase	13,824				
Muck.....	273,600	7.0	Coloma sand.....	9,792	.3
Plainfield sand.....	183,290	4.7	Superior fine sand.....	8,704	.2
Coloma fine sand.....	131,328	3.4	Superior clay loam	8,128	.2
Miami loam.....	118,656	3.0	Rolling phase.....		
			Superior loam, Rolling phase.....	7,552	.2
Superior fine sandy loam, rolling phase....	108,288	2.8	Fox fine sandy loam.....	6,976	.2
Plainfield fine sand, Poorly drained phase	78,780	2.5	Clyde loam.....	6,016	.2
	17,856				
Merrimac silt loam.....	91,584	2.3	Merrimac fine sandy loam	4,352	.1
Colby silt loam.....	14,400	1.9			
Rolling phase.....	60,480				
Vilas stony sand.....	59,328	1.5			

CHAPTER II.

GROUP OF HEAVY SOILS

COLBY SILT LOAM

Extent and distribution.—The Colby silt loam is one of the most important and extensive soil types in north central Wisconsin, but within the area covered by the present survey it occupies only about 117 square miles, and is confined to the western part of Langlade County where it occupies one continuous tract in Summit, Vilas, Ackley, and the western part of Peck and Upham Townships.

Description.—The surface soil of this type to an average depth of 10 inches consists of a light brown or grayish silt loam which contains a moderate amount of organic matter. Over the lowest portions there is sometimes a few inches of peaty or mucky material. The percentage of silt is high and the soil has a smooth feel which is characteristic of silt loams. The type is somewhat heavier and more compact, however, than the other silt loam soils of the area because of the higher clay content, and in a few places the type approaches a silty clay loam in texture. The lower portion of the surface soil is frequently mottled.

The subsoil consists of a yellowish brown, buff, or grayish compact silt loam which gradually becomes heavier with depth and grades into a silty clay loam or clay loam at from 16 to 20 inches. Below and sometimes above this depth the material is mottled with yellow, brown, and bluish and reddish brown, indicating poor under drainage. The lower subsoil below 24 to 30 inches has a pronounced reddish brown color which holds throughout the entire area, though its depth may be somewhat variable. Incorporated with the lower subsoil there are usually small irregular rock fragments, fine gravel, or particles of fine and medium sand which give the material a somewhat gritty feel. Where the drainage conditions are the most deficient this reddish brown color gives place to bluish gritty clay which is mottled.

While there are a few stones found upon the surface, they are not nearly as plentiful as on the Kennan silt loam and do not interfere with cultivation to any extent. While the amount of organic matter in the soil varies somewhat, being greater in the depressions where

there has been a slight accumulation, the texture, structure, and color of the type as a whole are remarkably uniform. Over the entire type an acid condition has developed in the soil and in most places this is very marked. Only a very few rock outcrops were observed and from records obtained it appears that the depth to bed rock over the type as a whole ranges from 4 to 50 feet.

Because of its heavy character this soil cannot be worked under as wide a range of moisture conditions as other types of the area. It is somewhat more difficult to handle than the Kennan silt loam.

Topography and drainage.—The surface of this type of soil varies from nearly level to undulating and gently rolling. The differences in elevation between the highest and lowest points will probably not exceed 40 feet, and all slopes are long and gentle. The typical portion of this type is nearly level or undulating and water runs off slowly, so that the natural drainage is deficient. Where the surface is more uneven and the natural drainage is better, it has been shown separately on the soil map and referred to as the rolling phase. On account of the heavy compact character of the subsoil, all of the main portion of the type could be tile drained to advantage.

Origin.—The material forming the Colby silt loam is the weathered product of the mass of ground-up rock left upon the surface of this portion of the State during the early periods of the Great Ice Age. It has been derived almost entirely from the old crystalline rocks. The soil has some of the characteristics of a residual soil and it is probable that in places the deep subsoil is residual. The surface soil may have been deposited in part by wind action.

Native vegetation.—The Colby silt loam was originally covered with a dense forest growth of hardwood and hemlock with a scattering of large white pine. Practically all of the pine has been cut, but there is still some virgin hardwood and hemlock. The hardwood consists of maple, birch, basswood, and elm, with some ash and oak. Where all of the merchantable timber has been removed a second growth of poplar and birch has sprung up.

*Present agricultural development.**—Practically all improvement on Colby silt loam in this area is confined to the rolling phase, where drainage conditions are better than on the portion of the type just described. When properly drained all portions of the Colby silt loam can be developed into good agricultural land well adapted to dairying and all general farm crops suited to the climatic conditions of this portion of Wisconsin.

*For chemical composition of Colby silt loam see page 25.

COLBY SILT LOAM—ROLLING PHASE

The chief difference between this phase and the portion of the type above described is in topography, the phase being gently rolling and always having sufficient slope so that surface water will run off readily.

Somewhat more than half of the Colby silt loam in this area is included in the rolling phase. The phase has not quite as large a supply of organic matter as the remainder of the type, but as far as texture, structure, origin and native vegetation are concerned it is very similar. About 15 to 20 per cent of the Colby silt loam—rolling phase is cleared and under cultivation, and agriculture is well advanced. All crops common to this section are successfully grown. Grasses and clover do especially well and the yields of hay range from $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre. Oats are grown as the leading small grain crop and yield from 35 to 50 bushels per acre. Wheat yields about 25 bushels per acre on the average, but the acreage is comparatively small. Some barley and rye are also raised and satisfactory yields are obtained. Corn is grown especially for fodder and ensilage and some years the crop will mature, though it cannot be depended upon every year.

Where the timber has been removed and the brush cut the type affords excellent grazing and this region as a whole is well adapted to the dairy industry in conjunction with general farming which is the chief type of agriculture being followed at present. The tendency seems to be toward the more extensive development of dairying.

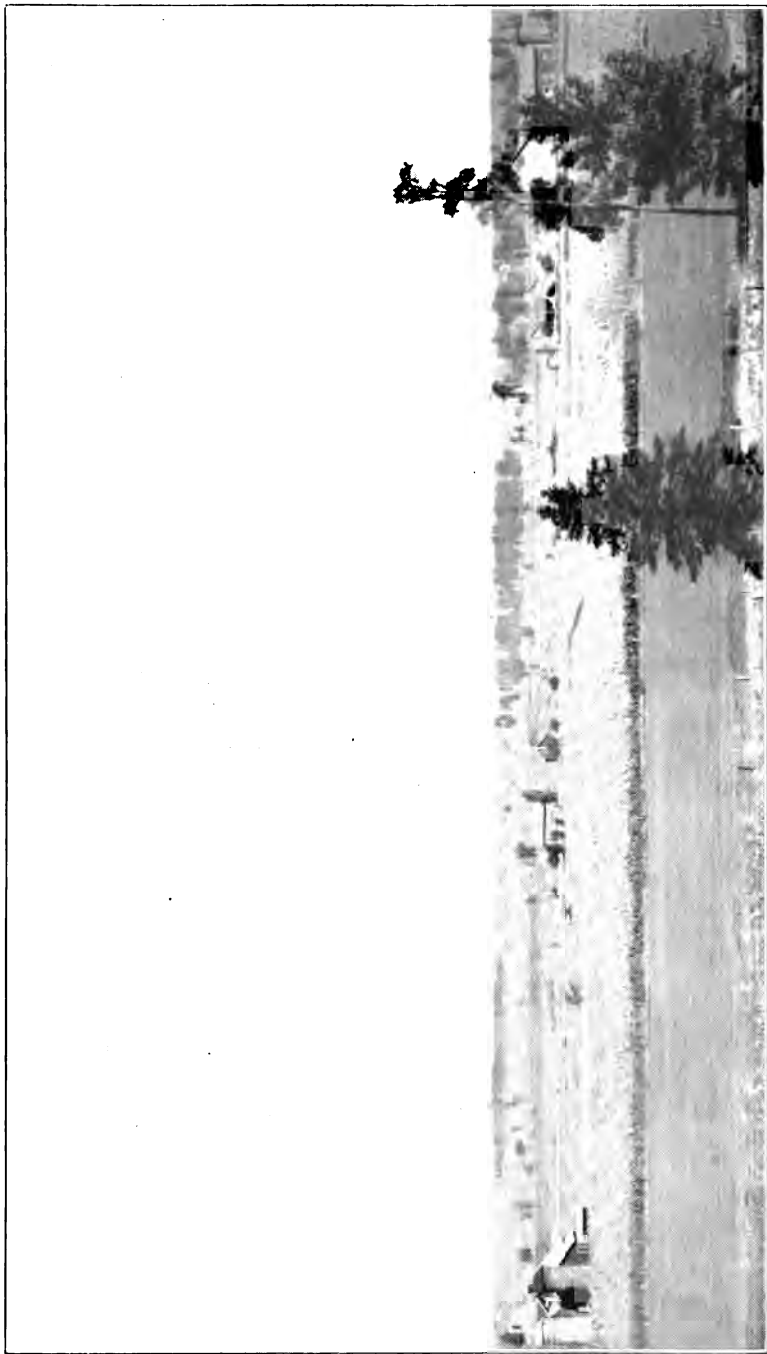
The crop rotation most commonly followed consists of corn followed by oats, with which clover or clover and timothy may be seeded; or the oats may be followed by a year of wheat, barley, or rye before the field is seeded to clover and timothy. Hay is usually cut for two years and the field may be pastured for a year before being again plowed for corn. Where there is much uncleared and brush land, however, such tracts usually provide sufficient grazing and so the cultivated fields on many farms are not used for grazing at any time during the rotation. Stable manure is the only fertilizer used and this is most often applied to sod.

ANTIGO SILT LOAM

Extent and distribution.—The Antigo silt loam is the most extensive type of the Antigo series in the region surveyed and it may be classed with the more important soil types of the area. The most extensive tract is found in the southwestern part of Lang-



COLBY SILT LOAM, ROLLING PHASE.
View showing typical surface features and well improved farmstead. In the present survey this type of soil is confined to the southwestern part of Langlade County.



VIEW OF ANTIGO SILT LOAM NEAR ANTIGO, LANGLADE COUNTY.

Note level topography, highly improved farms, and heavy crop of corn. In the vicinity of Antigo there are about 175 square miles of this class of land.

lade County where there is an unbroken area covering approximately 150 square miles. Antigo, Deerbrook, Bryant, Malcolm, and Ormsby are located upon this tract. Numerous other tracts of this soil, though of much smaller extent, are scattered throughout the northwestern half of the area surveyed.

Description.—The surface soil consists of a light brown or grayish brown friable silt loam which extends to an average depth of 12 inches. The content of silt is usually high, giving the material a smooth feel. The amount of organic matter present is comparatively small and the soil as a whole is acid. The subsoil consists of a yellowish or yellowish brown silt loam which gradually becomes heavier and grades into a silty clay loam. At an average depth ranging from 22 to 30 inches the material grades abruptly into beds of stratified sand and gravel. The depth to the sand and gravel is variable, however, and differences of from 1 to 4 feet may occur within a distance of a few rods. In general, it may be said that the type to the east of Antigo is somewhat lighter in texture than it is to the west. There is frequently a sprinkling of gravel upon the surface and a few stones ranging in diameter from 4 to 8 inches may also occur, though over areas where the silt loam is the best developed but little gravel and few stones are found.

While the major portion of the material mapped conforms to the above description, this soil is not uniform, but consists rather of a combination of several types so closely associated that in a general survey of this character the individual types of small extent could not be indicated separately on the soil map. The surface material varies from a silt loam to a fine sandy loam.

Topography and drainage.—The surface of this soil varies from level to very gently undulating, usually having a very gentle slope toward the water course along which it occurs. The extensive tract about Antigo in Langlade County is a prairie-like plain in which the differences in elevation do not appear to exceed from 6 to 10 feet in a distance of several miles. There is a very gentle slope towards the southwest.

While the surface of the major portion of the type is level, the underlying gravel and sand comes close enough to the surface in most cases to afford good drainage. Where these beds are three feet or more below the surface, however, the natural drainage is somewhat defective. Tile drains could be installed to advantage over these poorly drained areas. The soil retains moisture very well and crops seldom suffer from drought to as great an extent as soils of the same texture where the topography is more broken.

Origin.—The material composing the Antigo silt loam is alluvial and occurs as outwash plains and stream terraces, and was deposited by streams issuing from the ice sheet during glacial times. The beds of stratified sand and gravel found below the surface extend to a considerable depth and at Antigo are known to be 58 feet in thickness. The underlying rock is granite. The gravel found throughout the section quite generally consists of granite and other crystalline rocks.

Native Vegetation.—The original timber growth on this soil consisted of hardwood and hemlock with a very generous scattering of magnificent white pine, a little Norway pine, and hemlock. Of the hardwoods, maple predominated, with birch, basswood, elm, ash, and oak found in smaller amounts. In the vicinity of Ormsby in Langlade County there is still a considerable tract of standing timber.

*Present agricultural development.**—By far the greater proportion of the Antigo silt loam is cleared, under cultivation, and highly improved. It includes some of the finest agricultural land in northern Wisconsin and the area about Antigo is the largest solid body of this type of soil in the State. The leading type of agriculture followed at present consists of dairying in conjunction with general farming, with a strong tendency toward the more extensive development of the dairy industry, to which the region is well adapted. The chief crops grown are oats, hay, potatoes, corn—chiefly for silage, with some barley, rye, and wheat. Peas are a special crop of importance and sugar beets are also grown, though to a less extent. Poppy seed is grown for home consumption in many gardens and ginseng growing is a special industry of importance. Rape is grown as a pasture for hogs.

Probably the most common crop rotation which is followed at present consists of corn 1 year, oats for 1, 2, or sometimes 3 years, or oats followed by barley for 1 year. Timothy and clover are seeded with the grain and hay is cut for 1 or 2 years and the field may be pastured for a year before being again plowed for corn.

But little if any fertilizer other than stable manure is used and this is usually applied to the sod land. This type of soil is not difficult to plow, as it has a friable structure and works readily into a mellow seed bed. Fall plowing is desirable and quite generally practiced, though not as important as where the texture is a clay.

*For chemical composition and improvement of Antigo silt loam see page 25.

KENNAN SILT LOAM

Extent and distribution.—The Kennan silt loam is an important and extensive soil in the present survey. It covers a total area of 244.8 square miles and comprises some of the best undeveloped agricultural land in northern Wisconsin. Tracts of considerable size are found along Pine River in western Florence County, to the southwest of Crandon, to the east of Blackwell, and in various other parts of Forest County. In Langlade County there are important areas in northern Elton and Langlade Townships and smaller patches in the southern part of the county. In Shawano County it is confined to a large number of rather small tracts scattered throughout the western half of the county. It is not extensive in Oconto County, where it is confined to the northwestern section. The rolling phase of the Kennan silt loam, is much more extensive than the typical soil. A description of this phase follows the discussion of the typical soil.

Description.—The surface soil of the Kennan silt loam consists of a brown or light-brown, friable, loesslike silt loam, extending to an average depth of 12 to 14 inches. The subsoil consists of a light-yellow or yellowish-brown silt loam to silty clay loam which usually becomes somewhat heavier with depth, and silty clay loam or heavy clay loam is reached at from 18 to 20 inches. This heavy layer usually extends to an average depth of about 30 inches. The lower part of this section frequently contains some sand and the material sometimes becomes a gritty clay loam. Below 30 inches the subsoil grades into a bed of unassorted glacial till consisting of fine and medium sand and gravel with only a small percentage of silt and clay. Stones and boulders are present upon the surface, though they are not so large or so plentiful as on the rolling phase. There are tracts of considerable extent where they are almost lacking. It is seldom that large boulders are found on this type. The areas which occur in western Shawano County, however, are more stony and have a greater number of large stones than other portions of the type.

There are a number of variations in this type which are worthy of note. The depth of the silty material over sand and gravel is nearly as variable as in the rolling phase, though on the whole it averages deeper. It very frequently occurs that the unassorted till is 3 or 4 feet or even more below the surface, while there are a few tracts over which it is within 1 foot of the surface and where there is some gravel scattered over the surface of the soil. The shallow silt areas are usually confined to small tracts of the type, and most of the extensive

tracts have a silt covering of at least the average depth. In southwestern Shawano County a number of the shallow silt areas are found and there is also a variation in which there is a considerable proportion of fine sand incorporated with the silt. Such tracts, if of sufficient size, would be mapped as a heavy fine sandy loam or a loam. In such places the subsoil is often a sandy clay loam instead of a silty clay loam or silt loam. Another phase is found in southwestern Shawano County where the subsoil is rather heavy and red in color.

Topography and drainage.—The surface of the typical Kennan silt loam varies from nearly level to gently rolling. In most cases the natural drainage is thorough, but where the surface is level or gently undulating and the silty covering is 3 feet or more deep the internal drainage is somewhat deficient and tile drains are very advantageous in improving the land. This soil retains moisture very well, and because of the smooth topography there is no destructive erosion.

Origin.—This type is of glacial origin and consists of material ground from the underlying crystalline rocks. A large proportion of it is ground moraine. The areas which are gently undulating or nearly level may be in part till plains. It is known that in some places the sandy gravelly material in the deep subsoil is stratified, and such areas are doubtless outwash plains. It is probable that some of the outwash plains have been worked over by an ice sheet after being deposited, and where the surface is not level such tracts more closely resemble the Kennan than the Antigo soils.

Native vegetation.—The forest growth consists chiefly of maple, birch, and hemlock. Basswood, elm, and white pine are found to a less extent. Most of the pine has been cut, but the greater part of the hardwood and hemlock is still standing.

*Present agricultural development.**—Only a comparatively small percentage of this type is cleared and under cultivation, but it gives promise of becoming one of the most highly improved and important soils in the area. Much of this land is still owned in large tracts by lumbering companies, railroads, and individuals, and its development along the line of agriculture is retarded. As rapidly as the timber is removed and the land placed upon the market it is being taken up in small tracts and farms started. The districts where this soil is now being farmed are found chiefly in western Shawano County, southern Langlade County, and in Forest County in the vicinity of North Crandon, and also to the southwest of Crandon.

*For chemical composition and improvement see page 25.

The crops grown, the methods of farming followed, and the crop rotations practiced are practically the same as on the rolling phase. The main type is considered a more desirable soil than the phase. There are stone-free areas of considerable size on which such implements as potato diggers can be operated without difficulty, and for this reason it seems probable that the potato-growing industry will develop to a greater extent than on the rolling phase. Alfalfa can be grown successfully, provided the soil is limed and inoculated. Live-stock raising, dairying, potato culture, and small-grain growing seem well adapted to conditions found upon this soil, and most of the development now taking place is along these lines.

KENNAN SILT LOAM, ROLLING PHASE

Extent and distribution.—The Kennan silt loam, rolling phase, is closely associated with the typical soil, and is mapped in the same parts of the area. It is the most extensive soil mapped in the survey, and covers 1,153.8 square miles. While not extensively farmed at present, because of the numerous tracts of standing timber, which is still in large holdings, it gives promise of being one of the most important agricultural types of soil in this section of the State when fully developed. It occupies an extensive belt of country in the western half of the survey and reaches from the Michigan-Wisconsin line on the north border of Florence and Forest Counties to the southern boundary of Shawano County, a distance of nearly 100 miles. In Forest County and the western third of Florence County this soil occupies over 50 per cent of the total area, while in eastern and central Langlade and western Shawano Counties it is the predominating soil. It is also found as a narrow belt along the western margin of Marinette County and in the northwestern corner of Oconto County. Associated with this phase is the typical soil and numerous areas of Kennan fine sandy loam and Vilas stony sand, fine sand and sandy loam.

Description.—The soil of the Kennan silt loam, rolling phase, to an average depth of 10 to 12 inches consists of a brown or grayish-brown friable silt loam which has a smooth feel and contains a moderate amount of organic matter. The surface 6 inches is usually somewhat darker than the material immediately beneath because of the larger content of organic matter. When dry, the soil frequently has a gray, ashen appearance. It is usually free from coarse grains of sand and fine gravel, and the smooth, velvety feel is a remarkably uniform characteristic over most of this phase. The soil has somewhat the appearance of loess.

The subsoil consists of a yellow, yellowish-brown, or slightly grayish yellow silt loam which usually becomes heavier in texture with depth, grading into a silty clay loam at 16 to 20 inches. This heavier material extends to a depth of 20 to 26 inches, where fine gravel or sand is often incorporated with it. Below this depth the percentage of sand and gravel increases, and the lower subsoil usually consists of an unstratified mixture of light-yellowish or brownish fine and medium sand, with considerable quantities of gravel, but only a small proportion of silt and clay. The gravel is sometimes so plentiful as to prevent penetration with the soil auger.

A large number of stones and boulders occur scattered over the surface of this soil. These range in size from a few inches to several feet in diameter. In places of small extent the rocks are so numerous as to be an obstacle in the clearing of the land, while in other localities the surface is practically free from stones. Because of the irregularity of their occurrence it is impracticable to indicate the stone-free areas. Where stones are the most plentiful and fields are cleared, stone fences are common.

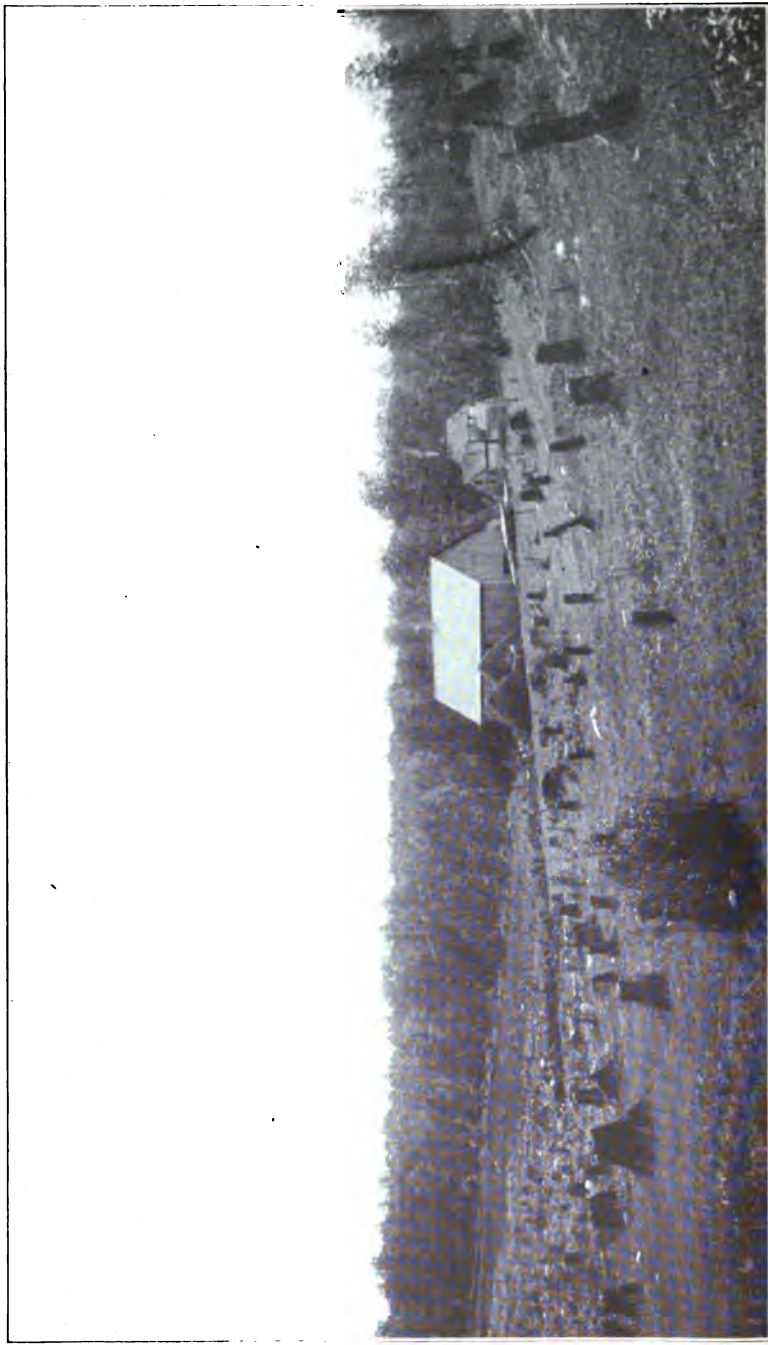
There are a number of variations in the phase which are worthy of note, although not of sufficient extent or importance to indicate separately on the soil map. On the tops of practically all the hills and ridges the silty covering over the sandy gravelly subsoil is thinner than typical, and on some of the sharpest ridges gravelly material outcrops and gravel is found upon the surface. Toward the foot of the slopes the silt covering gradually becomes deeper, and frequently along the lower slopes and across the valley to the next rise it is so deep that no gravel can be reached with the 3-foot soil auger. Where the slopes are gentle and the hilltops broad and nearly flat, the silt covering frequently continues of uniform depth. In the southeastern part of Forest County in the vicinity of Wabeno the surface soil contains a higher percentage of silt than typical and the subsoil is heavier and deeper, even on the hilltops, than is usually the case. In western Marinette County the phase is a little lighter than typical. In many localities there is a considerable amount of fine sand incorporated in both soil and subsoil, so that the soil approaches a fine sandy loam.

Topography and drainage.—The surface of the Kennan silt loam, rolling phase, varies from gently rolling to rolling and hilly, and in a few places, to rough and broken, though most of it may be classed as rolling. The surface is often in the form of a series of parallel ridges extending in a northeast and southwest direction. The highest portion of the ridges ranges from 50 to 150 feet above the intervening valley bottoms, but the slopes are seldom too steep to prevent the



KENNAN SILT LOAM, LANGDALE COUNTY.

Note the gently rolling topography. This type of soil with its rolling phase covers 22.9 per cent of the area surveyed. Corn is grown successfully in this region.



KENNAN SILT LOAM, ROLLING PHASE, NEAR WABENO, FOREST COUNTY.

This phase includes over 700,000 acres within the present survey. It is an excellent soil and capable of being highly improved. Most of it is still timbered.

use of modern farm machinery when the land is cleared. In many localities the slopes are long and gentle and it is frequently one-half mile or a mile, or more, from one hilltop to the next. In the vicinity of Crandon, around Stone Lake, and to the south in Forest County the hills are quite high and some of the slopes steep. To the southwest of Lakewood in Oconto County there is a considerable area which is extremely rough and broken and much of which is too steep for cultivation. This area comprises parts of secs. 35 and 36 in T. 33, R. 15, parts of secs. 31, 32, 33, and 34 in T. 33, R. 16, and parts of secs. 4, 5, 6, and 7 in T. 32, R. 16, Oconto County.

In the depressions between the hills and ridges there are a large number of swamps and lakes. The swamps consist chiefly of areas of Peat, and are most numerous in the northern part of Forest County, though marshy tracts occur to a greater or less extent throughout the entire region covered by this soil.

Because of the uneven surface and the loose, open structure of the deep subsoil, the natural surface drainage is excellent and the internal drainage is very good, except in a few places where the silty covering is deeper than usual and the surface is in the form of a valley or small depression, in which case tile drains could doubtless be installed to advantage. On many of the steeper slopes erosion will be a problem requiring attention when the land is cleared and put under cultivation. Where fields have been cleared and cultivated on the steeper slopes, small ravines soon form if the surface of the ground is not covered by a growing crop most of the time. These gullies enlarge quite rapidly and in time cut up the fields badly unless checked. Fortunately, as the country is new, means of preventing damage from erosion can be adopted as the land is cleared.

Origin.—The material composing this soil has been derived from the weathering of the glacial drift which covers this entire region, ranging in depth from a few feet to over 100 feet. It appears that the surface was considerably eroded before the decomposition of the drift and that the preglacial topography in general was quite similar to the present surface arrangement. The drift forms a veneering over the underlying rocks and was deposited chiefly as ground moraine, though many of the ridges have the appearance of being terminal or recessional moraines, and the hills frequently appear to be elongated drumlins.

Native vegetation.—The timber growth consisted chiefly of hardwoods and hemlock, with a scattering of white and Norway pine. A large proportion of the pine has been cut, but the phase still supports some of the most extensive hardwood forests remaining in Wisconsin. Over the northern part of Forest, the eastern part of

Langlade, the northwestern part of Oconto, and in scattered areas in Shawano County there are large tracts of virgin forest. The hardwood consists chiefly of maple and birch with a small amount of basswood and elm and a very little oak.

Present agricultural development.—Only a small part of the rolling phase has been put under cultivation, though large areas have been cleared of their timber and are now awaiting the settler. The most extensive developments are in Rolling, Norwood, Polar, and Evergreen Townships in Langlade County and in the western part of Shawano County. Enough has been done along the line of agricultural development, however, to demonstrate that the soil is well adapted to all the general farm crops suitable to the climate and that it is a naturally strong, productive soil and one of the best and most important soils, as well as the most extensive, in the area surveyed. General farming is the chief type of agriculture followed. The tendency seems to be toward the development of dairying and potato culture as the two most important lines of farming.

The chief crops grown are potatoes, hay, and oats, with some corn. Potatoes thrive and seem to be especially suited to the soil and climate. Yields range from 150 to 200 bushels per acre, often being considerably higher. Oats yield about 50 bushels and hay from 2 to 3 tons per acre. Clover and all kinds of grasses suited to the climate do remarkably well on this soil. Peas are grown to some extent and give very satisfactory yields. Barley, wheat, and sugar beets all grow well but are not produced to any extent in this new country. In the southern part of the area corn is a practically sure crop, being depended upon to mature nearly every year, while in the northern part of the area where this phase occurs the season is somewhat shorter and there is more danger from early fall frosts. Corn for silage, however, can be grown very well over the entire area of this soil, and early maturing varieties are being introduced.

As most of the region covered by the rolling phase is still new, no definite systems of crop rotation or methods of cultivation have been put into general practice. The virgin soil is strong and productive and the question of maintaining soil fertility has not received serious consideration.

Kennan silt loam, with its rolling phase, offers more opportunities for agricultural development than any other soil in the area surveyed, and where it predominates the prosperity of the community depends chiefly upon its development and improvement.

Cut-over land of this phase ranges in price from about \$12 to \$25 an acre, depending chiefly upon the location. Forested land ranges from \$18 to about \$50 an acre, according to the location and stand of

timber. Partly improved farms are valued at \$35 to \$50 or \$60 an acre, depending upon the location, buildings, and the amount of land cleared and under cultivation.

CHEMICAL COMPOSITION AND FERTILITY OF COLBY SILT LOAM,
ANTIGO SILT LOAM, AND KENNAN SILT LOAM

The soils of the Colby, Antigo, and Kennan series have a good supply of the mineral elements phosphorus and potassium.

Phosphorus.—The total amount of phosphorus in an acre to a depth of 8 inches varies from 1100 to 1400 pounds. This would be sufficient for 100 to 150 crops if all were available, but it is never practicable to secure good growth from such soils after the total phosphorus has been reduced to six or eight hundred pounds and better results are always secured when the total phosphorus content of this layer of soil is retained at from 1500 to 2000 pounds per acre 8 inches. A farmer on this land, therefore, should adopt plans which will maintain the present supply of this element rather than attempt to draw on it even for a short number of years. The availability of this element requires a good supply of organic matter.

Potassium.—The element potassium exists in very much larger amounts in these soils than does the element phosphorus—in fact they contain on the average approximately 30,000 pounds of this element per acre to a depth of 8 inches. This is a sufficient supply to meet the demands of heavy crops for several hundred years. The entire problem with reference to potassium, therefore, is connected with its availability. When a good supply of active organic matter is present it can be assumed that there is sufficient potassium made available for practically all crops grown on this land. In the case of a few special crops requiring unusually large amounts of this element, such as cabbage and tobacco, the use of potash fertilizers may in some cases be profitable. The system of farming followed will also influence the potassium supply. A large part of this element goes to the stalks and straw of the plant so that if the hay and rough forage is fed the greater portion of this element is returned to the land in the manure—differing radically from phosphorus which goes to the grain and is, therefore, more likely to be sold.

Organic matter and nitrogen.—Compared with prairie soils which have shown a lasting fertility, these soils are distinctly low in organic matter and nitrogen. In fact, most upland soils of wooded regions are low in organic matter. However, the vegetable matter

which they do contain when first cleared and broken is of an active character, but provision should be made for maintaining and increasing this material. When stock raising is practiced manure is available and is of course good as far as it goes, but on comparatively few farms is there sufficient manure produced to maintain the organic matter in soils of this character and other means should be used to supplement the barnyard manure. Green manuring crops should be used as far as possible, turning under the second crop of clover whenever this can be done rather than using it for pasture. Seeding clover in corn at the last cultivation will secure good growth when the season is favorable. Cultivated ground when used for pasture should not be grazed closely.

Nitrogen is perhaps the most essential element of plant food and large amounts are used by all crops. It exists only in the organic or vegetable matter of the soil, there being none whatever in the earthy material derived from the rocks. Soils which are low in organic matter are, therefore, also low in nitrogen. By all means the cheapest source of this element is through the growth of legumes such as clover, alfalfa, soy beans, etc., which collect it from the atmosphere. When these crops are turned under they contain an abundance of this element. When fed to stock a portion only is returned to the land. But when land of the character of that under discussion is used for mixed farming so that at least one-fourth produces a good crop of clover or alfalfa each year the supply of nitrogen can be maintained on a dairy or stock farm, but where any considerable portion of the land is in crops which are sold entirely one-third or more would have to be in some legume crop to maintain the nitrogen supply.

Acidity and liming. Since all of these soils were formed from rocks not containing lime carbonate they are essentially all acid. The degree of acidity varies from one which would require 1000 to that which would require 5000 pounds or more lime to correct. This acidity is not in itself a direct detriment to the growth of most farm crops, but does interfere with the growth of the best legumes. Clover will do well while this soil is new even though acid, but after this land has been cropped a number of years the acidity should be corrected to secure the best results with medium red or mammoth clover. Alfalfa is very sensitive to acidity and lime in some form must be used to secure good results with this crop even on new land.

Crops.—The Antigo and Kennan soils are adapted to a wide range of crops including corn, potatoes, and root crops as well as grasses and small grains. The Colby soils are not particularly well adapted to root crops on account of their rather inadequate subsoil drainage

and their stickiness. They are, however, exceptionally well adapted to grains and grasses. Fields on the Colby soils having good slope and surface drainage can be made to produce good crops of corn by careful management. The soils of these types are well adapted to the development of dairy farming on account of their unusual fitness for the growing of hay and pasture.

SUPERIOR LOAM—ROLLING PHASE

Extent and distribution.—This type of soil has a total area of approximately 11 square miles. The largest tract is located in eastern Florence County about 9 miles south of Florence in Homestead Township. The remainder of the type occurs in several small patches about 6 miles southwest of Suring in Oconto County.

Description.—The surface soil to an average depth of from 10 to 12 inches varies from a very fine sandy loam to a loam of a gray to yellowish-gray color. The subsoil to a depth of 36 inches and over consists of a heavy stiff compact pinkish-red clay, which well records indicate frequently extends to a depth of 80 feet. The depth of the surface soil is quite variable and may frequently extend to 18 inches, while in other localities the underlying clay outcrops over areas which are too small to be shown in a general survey.

Topography and drainage.—The surface varies from undulating to very gently rolling with a few small tracts that are nearly level. As a type the natural surface drainage is fairly good, but the subsoil is so heavy and compact that the internal drainage is defective. The rougher portions of the type occur adjacent to the stream courses where erosion has been most pronounced.

Origin.—The heavy red clay subsoil is doubtless of lacustrine origin but since its first deposition it has been influenced more or less by glacial action, weathering, and erosion. The sandy or loamy covering was probably more recently deposited than the clay. While the red clay is somewhat calcareous, there is no limestone present, except a very small amount in the area in Oconto County.

Native vegetation.—The original timber growth consisted chiefly of maple, birch, and elm, with some white and a little Norway pine. Practically all of the merchantable timber has been cut and where not cleared and improved a dense second growth has sprung up.

*Present agricultural development.**—Probably over 40 per cent of the Superior loam is cleared and under cultivation. The area in Florence County is a little far north for corn to mature with certainty, although on all of the type corn for silage can readily be

*For chemical composition and improvement see page 29.

grown and most seasons it can be matured. Oats, barley, wheat, and hay are crops well suited to this soil and all give good yields. It is well adapted to general farming and dairying. The farming communities on this soil are comparatively new, and definite systems of cultivation and crop rotation have not been carefully worked out. On the portions of the type where the drainage is most defective hay is grown more largely than any other crop and some of the land is used for pasture.

SUPERIOR CLAY LOAM—ROLLING PHASE

Extent and distribution.—This type of soil is of small extent and does not occupy over 12 square miles. It is confined to south eastern Shawano County in Maple Grove Township, and to Maple Valley and Spruce Townships in Oconto County. The tracts are seldom over 1 square mile in extent and are quite widely scattered.

Description.—The surface soil to an average depth of 8 inches consists of a dark gray or dark reddish-brown silty clay loam containing a comparatively small amount of organic matter. The subsoil consists of a heavy compact pinkish-red clay or silty clay loam which extends to a depth of over 3 feet. It contains considerable lime carbonate and the soil is seldom acid. The texture varies somewhat, though chiefly in the surface soil. In some of the lower lying places there is more organic matter present and the surface is dark gray or almost black. Such variations, however, are of too limited extent to be indicated in a general survey. The type as a whole resembles the Superior loam—rolling phase, but differs in having a heavier surface soil, and in containing a smaller amount of gravel.

Topography and drainage.—The surface varies from gently undulating to gently rolling and there is sufficient slope over the type as a whole to afford fairly good surface drainage. The subsoil is so heavy and compact, however, that the internal drainage is poor and water moves through the soil very slowly. The lower portions of the soil are in need of tile drains and even gentle slopes would be benefited by tiling.

Native vegetation.—The original timber growth consisted chiefly of large white pine with some maple, hickory, elm, and basswood. All of the timber has been removed and practically all of the type is now under cultivation.

Present agricultural development.—This type is considered to be a good general farming soil and in this area is devoted to the raising of timothy and clover, and small grains including oats, barley, and wheat. Some corn is also raised and sugar beets and peas are two

special crops grown to a limited extent. The heavy character of the soil makes it somewhat late, but it produces good yields under proper conditions of moisture and cultivation. The type is more difficult to cultivate than most other soils in the area, and there is danger of puddling and baking if plowed too wet. But when worked at the proper time a fairly good seed bed can be secured with comparatively little difficulty.

CHEMICAL COMPOSITION AND FERTILITY OF SUPERIOR LOAM AND CLAY LOAM—ROLLING PHASES

The chemical analyses of the Superior loam and clay loam soils show that their phosphorus content is somewhat lower than the average of other silt loams and clay loams in the State, while the potassium content is considerably larger. Their content of organic matter is somewhat below the average of soils of this texture. In regard to lime they vary within very wide limits, in some sections being acid, while in others they contain as high as 25 or 30 per cent of lime carbonate.

Phosphorus.—The comparatively small total amount of phosphorus contained in these soils together with the relatively large amount of iron oxide renders this element somewhat unavailable to growing crops and makes it important that farmers operating on this type of soil see to it that the available supplies of this element are maintained or increased either through the use of feeding stuffs high in this element or the purchase of sufficient phosphate fertilizers. Experiments on this soil at Ashland showed a large increase through the use of phosphate fertilizers in addition to manure. The following table gives the results of some of these experiments.

Crop	10 tons manure only	10 tons manure and 1000 lbs. rock phosphate	Per cent of increase
Potatoes.....	87 bu. per A	128 bu.	47
Rutabagas.....	108 bu. per A	137 bu.	27
Corn.....	30.4 bu. per A	36.8 bu.	21
Clover hay.....	2223 pounds	3177 pounds	43
Clover seed.....	217.5 pounds	336.7 pounds	47

The importance of having sufficient supplies of this element is made still greater by the relatively poor drainage which the Superior clay loam has and its consequent tendency to be cold so that crops are slow in maturing. The element phosphorus is particularly helpful in hastening the maturity of crops and the formation of seed.

Potassium.—These soils average over 50,000 pounds of this element per acre to a depth of 8 inches. This potassium, however, in the form in which it exists in the soil is not available to crops and becomes so only as a result of chemical changes which are chiefly brought about through the action of organic matter. When a good supply of active organic matter is maintained the quantity of potassium is sufficient to supply growing crops almost indefinitely and it is only in the case of fields low in organic matter or where crops using unusually large amounts of available potassium are grown that fertilizers containing this element need be used.

Nitrogen and organic matter.—Nitrogen exists in the soil almost entirely in combination with organic or vegetable matter. In this soil the vegetable matter is relatively low and should be increased. The accumulation of organic matter high in nitrogen is most readily brought about through the growth of legumes such as clover, alfalfa, or soybeans. These may either be turned under as green manuring crops in which case all of the nitrogen collected from the atmosphere is returned to the soil and made available to succeeding crops, or they may be fed to animals and the manure returned to the soil so that a portion at least of the nitrogen gathered from the atmosphere is returned to the land to add to the supply already there. Whatever system of farming is followed on this type of soil should involve a rotation one member of which is a legume.

Lime and soil acidity.—This soil was originally laid down in an extension of Lake Superior as a sediment and in this a considerable amount of lime carbonate was deposited. This water-deposited soil was then worked over by the ice during the glacial period. Since this time the lime has been dissolved out of portions of the soil to a considerable extent, but other parts, less pervious to the water or containing larger amounts of lime, still retain considerable quantities of this material. As a result these soils have become acid in patches, but as a whole are not acid and the subsoil still generally contains considerable lime. This is particularly favorable to the growth of clover and alfalfa, but where sorrel or other plants show the development of acidity lime should be used especially for alfalfa.

CHAPTER III.

GROUP OF FINE SANDY LOAM SOILS

KENNAN FINE SANDY LOAM

Extent and distribution.—The Kennan fine sandy loam is one of the most extensive soil types in the area surveyed and covers approximately 670 square miles. It is found in all of the six counties where crystalline rocks make up the underlying geological formation, but it is most extensive in Marinette and Shawano Counties. The type is closely associated with the Vilas fine sand on the one hand and the Kennan silt loam on the other. Along the southern border of its occurrence in Marinette, Oconto, and Shawano Counties it grades into soils of the Coloma series with such a gradual change that the line between the two series is an arbitrary one.

Description.—The surface soil of the Kennan fine sandy loam to an average depth of 12 inches consists of a light brown or yellowish-brown, mellow, friable fine sandy loam. The surface of cultivated fields when thoroughly dried has a grayish appearance but becomes somewhat darker as the content of moisture increases. The subsoil consists of a light yellowish-brown to yellow fine sandy loam which usually becomes coarser in texture and somewhat lighter in color with increased depth, so that the last 6 to 10 inches in the 3 foot section are mainly yellow sand and gravel. The greatest amount of gravel occurs below the depth of 18 or 20 inches. Stones and bowlders are plentiful on the surface and through the soil section, but rarely as numerous as on the silt loam, and they seldom retard agricultural development. Their occurrence is irregular and there are areas of considerable size which are practically stone-free. A variation from the typical soil was noticed in a number of places where both the soil and subsoil were heavier than typical. The change from the Kennan to the Superior fine sandy loam—rolling phase, is a very gradual one, and in this general survey some small areas of one type have been included with the other.

Topography and drainage.—The surface of this type varies from gently rolling to rolling and hilly. As a type it is not quite as rough as the average Kennan silt loam. There are a few places of rather limited extent where the surface is only undulating. Such

an area occurs due east from Boot and Pickerel Lakes in Florence County. A similar tract was found in Sections 33 and 34, Town 34, Range 10 East, in Langlade County. A few other small tracts were also noted, but mostly of such limited extent as to make their separation impracticable. On account of the uneven surface features of this type and the loose open structure of the subsoil, the natural surface drainage is excellent.

Origin.—This type owes its origin to the weathering of glacial till which was deposited over the crystalline rocks and it consists of material which was derived largely from this geological formation through the grinding action of the ice and subsequent weathering. A portion of the type may consist of lateral or recessional moraines.

Native vegetation.—The timber growth over this soil consisted of a mixture of white pine, hemlock, and hardwoods. On the lighter and coarser textured phases some Norway pine was also found. Hemlock and maple are the most plentiful, though there is also a considerable amount of birch, basswood, some oak, and a little elm. Over the eastern portions of the type there is also some beech. In Marinette County the white and Norway pine seemed to be the predominating growth.

Present agricultural development.—Probably not over 10 per cent of this soil is in improved farms, but it is a good productive soil, it has a most desirable texture for this portion of the State, and is adapted to a wide range of crops. Farming on the Kennan fine sandy loam in this region is new but promising. The chief crops are oats, rye, potatoes, timothy and clover hay, and corn. Buckwheat, peas, sugar beets, and cucumbers are other crops grown to a limited extent. Potatoes, oats, and clover are the most common crops and they are often grown in rotation as given. When the soil is new clover does well; on older fields, however, some difficulty may be experienced in getting a good stand, probably on account of the acid condition which is more harmful as the fertility of the soil is reduced. Alfalfa was seen growing in a few places.

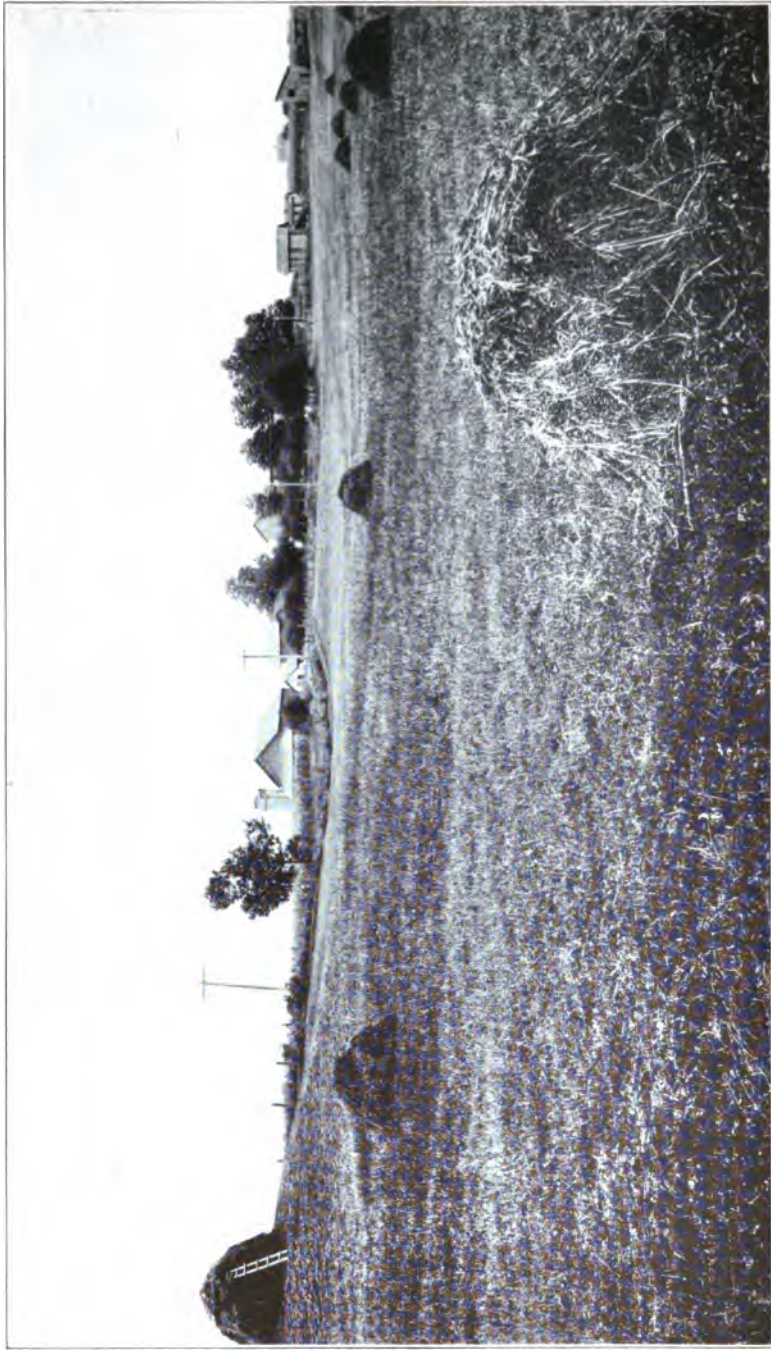
There is a thriving apple orchard of over 750 trees in bearing just south of Mountain, Oconto County, where Red Astrakhan, Early Harvester, Duchess, Wealthy, Snow, and Longfield are among the varieties of apples being successfully grown. Several varieties of crab apples are also being grown successfully. Bush fruits such as raspberries and blackberries do very well and they are found growing wild through all of the slashings. Strawberries also do especially well on this type.

Dairying is being built up as the country settles and is yearly becoming more important.



VIEW SHOWING TOPOGRAPHY AND TIMBER GROWTH OF KENNAN FINE SANDY LOAM.

Portions of this type are somewhat more rolling than the illustration indicates, but it is a good soil, easy to work, is capable of being highly developed, and it has a promising future. There are over 400,000 acres of this class of land in the area surveyed.



VIEW OF MIAMI FINE SANDY LOAM NEAR GILLET, OCONTO COUNTY.

Undulating to gently rolling topography, and well improved farms are characteristic of this type of soil as found in Marinette, Oconto and Shawano Counties. Second crop of clover in foreground.

CHEMICAL COMPOSITION AND FERTILITY OF KENNAN FINE SANDY
LOAM

This soil is only a little more open in texture than the silt and clay loam types. It has a good water-holding capacity and will support very good pasture, but the somewhat higher percentage of fine sand which it contains reduces the water content of the surface somewhat so that it warms up more readily in the spring and has less tendency to bake and crack than the heavier soils. These qualities make it better adapted to such crops as corn and potatoes than are the heavier types.

The total amount of the plant food elements phosphorus and potassium is nearly if not quite as large in the Kennan fine sandy loam as in the Kennan silt loams. However, it has rather less organic matter and this together with the somewhat coarser texture results in a slower rate of chemical change by which the inert plant food of the soil becomes available to crops. For this reason the increase in the supply of active or fresh organic matter and the use of available plant food either in the form of stable manure or of commercial fertilizers becomes more important and especially when crops such as potatoes which are sold from the farm, and of which heavy yields must be grown to be profitable, are produced.

The increase in the supply of active organic matter is of the utmost importance. A high degree of fertility cannot be maintained in this soil unless about twice as large an amount of organic matter is developed as that which it originally had. The plowing under of legumes, such as a second crop of clover or a crop of soybeans, is the best method of securing this result. The application of phosphorus and potassium fertilizers can best be made for these crops, since it secures a much larger growth of these crops themselves and becomes available through their decomposition to the following crops of corn or potatoes.

This soil was derived from rocks devoid of lime carbonates and therefore has a marked tendency to become acid. The degree of acidity is usually only slight in the new soil, but increases as the land is cropped from year to year. This acidity does not affect the growth of most crops directly, but makes it more difficult to maintain a good degree of fertility. This is true because it is a condition unfavorable to the continued growth of the best legumes—clover and alfalfa. The slight degree of acidity does not interfere with the growth of clover while the soil is comparatively new, but does reduce the yields as the fertility is reduced by further cropping and even in

the virgin condition this soil acidity interferes with the growth of alfalfa. It is also a condition unfavorable to the maintenance of a good supply of readily available phosphorus in the soil. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop and also to watch the growth of clover carefully from year to year, so as to begin the use of lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

This type of soil is well adapted to general farming and some special crops such as potatoes can also be grown to good advantage.

SUPERIOR FINE SANDY LOAM

Extent and distribution.—The Superior fine sandy loam occupies a total area of approximately 42 square miles. The largest occurrence is in southeastern Shawano County in Navarino, Angelica, and Maple Grove Townships. In Oconto County there is another quite extensive irregular tract, chiefly in Chase Township. In Marinette County there are several small patches about 2 miles south of Dunbar.

Description.—The surface soil to an average depth of 10 inches consists of a light brown to dark brown fine sandy loam, which frequently contains a large percentage of very fine sand. The supply of organic matter is usually limited. The subsoil consists of a fine or very fine sandy loam, or fine sand of a yellowish color which may become gray in some of the poorly drained places. This material extends to a depth ranging from 20 to 30 inches where a heavy stiff red clay is encountered. Lenses of fine sand are sometimes found in the heavy clay. The depth of this bed of red clay is quite variable. It may not be encountered until a depth of 36 inches is reached or it may occur within 10 inches of the surface and outcrop frequently. In some places the texture of the surface soil is a loam or clay loam, while in other places the surface is so shallow that the underlying clay will be turned up by the plow when put under cultivation. Such variations, however, are all of too limited extent to be indicated on a general soil map. The surface is free from stones and boulders. The red clay is of a calcareous nature.

Topography and drainage.—The surface of this type of soil is level or only very gently undulating and on account of this and the heavy character of the subsoil the natural drainage is frequently defective.

Origin.—The heavy material composing the subsoil is undoubtedly of lacustrine origin. The surface soil was probably deposited over the clay at a date somewhat later than the deposition of the clay and probably during the last period of glaciation.

Native vegetation.—The original timber growth consisted chiefly of maple and birch with some hemlock and elm and a scattering of white and Norway pine. Most of the merchantable timber has been cut and a second growth of birch and poplar is common.

*Present agricultural development.**—Probably about 50 per cent of this type of soil is cleared and under cultivation at present. Dairying in conjunction with general farming is the chief type of agriculture followed. In Navarino Township, Shawano County, there is a very thrifty prosperous farming community developed on this soil. The chief crops grown consist of corn, oats, and clover and timothy hay. Some barley, potatoes, and a little wheat are also raised and the average yields of all of these crops where fields are sufficiently drained are about equal to the yields on the Miami fine sandy loam. The soil is not difficult to cultivate except in a few places where the clay subsoil comes near the surface or outcrops.

FOX FINE SANDY LOAM

Extent and distribution.—The Fox fine sandy loam is one of the soil types of minor importance, occupying a total area of not more than 11 square miles. The largest continuous area is found from $1\frac{1}{2}$ to 5 miles northeast from Gillett in Oconto County. The remainder of this soil is found in the southern part of Shawano County where it is confined to small scattered areas in Waukechon, Hartland, Navarino, and Lessor Townships.

Description.—The surface soil of the Fox fine sandy loam to an average depth of 12 inches consists of a light brown or grayish brown friable fine sandy loam, which contains a rather low percentage of organic matter. The upper portion of the subsoil consists of a fine sandy loam somewhat heavier than the surface soil or a brown sandy clay loam. At from 20 to 24 inches this material grades quite abruptly into a light brown fine sandy loam containing a high percentage of fine sand and in places medium sand. The subsoil is stratified and beds of lighter textured material alternate with thin layers of fine sandy loam and sometimes clay loam.

While a small amount of gravel occurs with the soil material, no gravel deposits or beds of any size were found underlying the type. The most extensive deposit occurs in the area 2 miles south of

*For chemical composition and improvement see page 37.

Bonduel in Shawano County. About 40 per cent of the gravel in the soil and the stones and bowlders upon the surface consist of limestone.

As found in Shawano County the Fox fine sandy loam is somewhat lighter in texture than the description above would imply. The subsoil seldom contains material heavier than a fine sandy loam, except in the small area due south of Bonduel, where the tract as a whole approaches a loam.

Topography and drainage.—The surface of the Fox fine sandy loam varies from level to very gently undulating. The slight undulations which frequently occur appear at intervals of from 10 to 15 rods and the difference in elevation within such distance will range from 2 to 3 feet.

On account of the level character of the surface and the fact that the subsoil of the Oconto County tract is quite heavy in places, the natural drainage is somewhat deficient and tile drains could be installed to advantage over a portion of this type. In Shawano County the most of this soil would not require drainage. The lighter portions of the type, especially where slightly elevated, are subject to drought and when improved and cultivated, crops will doubtless suffer somewhat from lack of moisture during portions of each growing season.

Origin.—The material composing this type of soil occurs as outwash plains or stream terraces and was doubtless deposited by waters issuing from the ice sheet. Most of the soil came from the underlying limestone and the presence of limestone material keeps the subsoil from being acid. The surface soil has been leached to a considerable extent and is frequently found to be slightly acid.

Native vegetation.—White and Norway pine, maple, beech, oak, and some elm were all to be found upon this soil. On the heavier portions the hardwoods seemed to predominate, while on the lighter tracts the pine was the most plentiful. Practically all of the merchantable timber has been removed and where not under cultivation there is now a growth of small poplar, birch, and white pine.

*Present agricultural development.**—The greater proportion of the type in Oconto County is cleared and under cultivation. In Shawano County probably $\frac{1}{3}$ or $\frac{1}{2}$ of this soil is cleared. General farming is the type of agriculture followed and dairying is the most important branch. The crops most commonly grown are clover, corn, rye, oats, and winter wheat. The rotations followed and average yields obtained from the tract in Oconto County are about the same as for the Miami fine sandy loam. In Shawano County the yields

*For chemical composition and improvement see page 37.

will not average quite as high owing to the fact that the soil is somewhat lighter in texture.

ANTIGO FINE SANDY LOAM

Extent and distribution.—The Antigo fine sandy loam is of very limited extent and of minor importance. The largest tract of several square miles is found along the Brule River about 8 miles northwest from Florence in Florence County. Other small tracts occur in Germania and Almon Townships in Shawano County.

Description.—The surface soil of this type to an average depth of 8 to 10 inches consists of a light brown fine sandy loam. In structure the material is rather loose and open, but it is noticeably heavier than the Plainfield fine sand. The subsoil consists of a yellow fine sand which usually becomes somewhat coarser with depth and grades into a medium sand at from 2 to 3 feet. In a few places the subsoil was found to be slightly sticky, owing to the presence of a small amount of clay, but as a rule the only difference between this type and the Plainfield fine sand is the greater amount of silt and clay in the surface soil of the fine sandy loam.

Topography and drainage.—The surface is level to very gently undulating, and on account of the loose open character of the subsoil the natural drainage is good and usually somewhat excessive.

Origin.—The soil consists of alluvial material which has been deposited chiefly as stream terraces. The parent material was chiefly from crystalline rocks which were ground up by glacial ice. There is no limestone material present in any of the soil and an acid condition exists in both soil and subsoil.

Native vegetation.—The original timber growth consisted chiefly of white and Norway pine. The type is better than land which usually supports a growth of Jack pine. All of the timber has been removed and it is now all stump land.

Present agricultural development.—While this type of soil is somewhat better land than the Plainfield sand or fine sand, none of it has been cleared and put under cultivation. The distance from settlements probably is the chief reason for this, another being the fact that pine stumps are numerous and their removal would be difficult and expensive.

CHEMICAL COMPOSITION AND FERTILITY OF SUPERIOR, FOX, AND ANTIGO FINE SANDY LOAMS

These types of soil occur over comparatively small areas usually adjoining areas of the silt loam types of the same name. In chemical

composition these soils do not differ much from the Kennan fine sandy loam, with the exception of the Superior fine sandy loam which has more lime in the subsoil. So far as methods for maintaining and increasing the fertility are concerned, they should be the same as those outlined on page 000 for the management of the Kennan fine sandy loam. The Superior, Fox, and Antigo soils, however, are nearly level in topography and as a result often have relatively poor under drainage, making tiling or the use of open surface drains necessary. Proper care in this respect together with the use of methods for increasing the organic matter and available plant food in the soil will build up and maintain these soils in a high degree of fertility.

SUPERIOR FINE SANDY LOAM—ROLLING PHASE

Extent and distribution.—The Superior fine sandy loam—rolling phase is one of the important soil types in the area surveyed from the standpoint of acreage and also from the standpoint of agricultural development. It is confined to Shawano, Florence, and Oconto Counties and comprises a total area of about 170 square miles. Two distinct tracts are found in Shawano County—the first is directly southwest and west from Shawano, chiefly in Richmond and Belle Plaine Townships; and the second is in the southeastern corner of the county in Hartland, Angelica, Lessor, and Maple Grove Townships. This last named tract is the largest unbroken area mapped and from an agricultural standpoint it is one of the best developed regions in the whole area surveyed. In Oconto County the type is confined chiefly to the vicinity of Suring, in Howe, Maple Valley, and Spruce Townships.

Description.—Under normal moisture conditions the surface soil to an average depth of 10 inches consists of a grayish brown to brown fine sandy loam. The amount of organic matter is rather low, but the soil is mellow and friable and all cultural operations can be conducted without difficulty.

The surface soil rests upon a yellowish brown fine sandy loam somewhat lighter in texture than the surface material as well as lighter in color. This light stratum usually extends to a depth of from 16 to 20 inches where the subsoil changes abruptly into a heavy compact pinkish red gritty clay loam or clay. There are present upon the surface and mixed with the soil varying amounts of gravel and frequently a few bowlders are found associated with the soil. Taking the type as a whole the stones are not sufficient to detract at all from the agricultural value of the type. Over the portions of the type in Florence County and central Shawano County



SUPERIOR FINE SANDY LOAM, ROLLING PHASE, NEAR BONDUEL, SHAWANO COUNTY.

Note the gently rolling topography, which insures good natural drainage. This is an excellent general farming soil and is highly improved.



VIEW OF FOX FINE SANDY LOAM EAST OF GILLETT, OCONTO COUNTY.

Showing characteristic level topography and highly improved farm. The surface features are typical of all Fox and Antigo types of soil.

the gravel and stones mixed with the soil are chiefly granitic. In Oconto County there is considerable limestone gravel and some limestone boulders. In southeastern Shawano County fully 95 per cent of the gravel mixed with the soil is limestone and the underlying rock is also limestone.

There are a number of variations in the type which may be noted. There are places where the depth to the underlying clay is greater than the average depth and in some of these localities the clay is below the reach of the 3-foot auger. This phase is confined to the areas found in Oconto County. Then there are also small tracts where the clay comes closer to the surface than typical and in some localities the surface covering has been entirely removed. Such spots are most noticeable on the knolls in freshly cultivated fields. While some such tracts are found in Oconto County, probably the larger proportion occurs in Shawano County. Both of these variations, however, occur in such small tracts that in a general survey they could not be indicated on the soil map.

The extensive area of the Superior fine sandy loam—rolling phase in southeastern Shawano County differs somewhat from the typical soil. The lighter colored material immediately below the surface soil is often lacking or much thinner than usual, and the heavy underlying clay thus comes closer to the surface than over the remainder of the type. The surface soil is frequently heavier than typical also and may be described as a heavy fine sandy loam which in places grades into a loam. This whole tract may, therefore, be considered as a heavy phase. In a detailed survey it is probable that in addition to the fine sandy loam, a loam and a clay loam could be recognized.

This type is largely associated with the Miami fine sandy loam in Oconto and southeastern Shawano Counties. The line between these two types is not always sharply drawn because the change from one to the other is a gradual one. In the large tract to the southwest of Shawano this type is associated with the Coloma fine sandy loam.

Topography and drainage.—The surface varies from undulating to gently rolling and rolling, though the amount of land that is undulating is comparatively small. A portion of this soil in Oconto County possesses long gentle slopes from relatively broad ridge tops, and upon these slopes there is frequently superimposed a series of low mounds which give a somewhat hummocky appearance. In Shawano County there is more variation in the surface and in a few places it is hilly. The differences in elevation from the highest hilltops to the bottom of the intervening valleys will probably

exceed 200 feet. The slopes, however, are nowhere too steep to be cultivated and practically all of the type is highly improved. A few pot holes occur on this soil but even in such places there is but very little waste land.

On account of the uneven topography the natural surface drainage is good over the greater proportion of the type. The subsoil is frequently quite heavy and compact, however, and the internal drainage is often somewhat defective.

Origin.—The material composing the subsoil was originally laid down as a lacustrine deposit. After its first deposition it appears to have been greatly influenced by glacial action. The advance and retreat of the ice sheet not only reworked the lacustrine material but it also ground up the underlying rock and mixed it with the material from which the soil has been derived. Thus we now find a large amount of limestone mixed with this red clay in the limestone region, and a considerable amount of granite where the glacier traversed the regions underlain by this class of rock.

The heavy red subsoil of this type is of a calcareous nature and contains large amounts of lime carbonate, especially throughout the region underlain by limestone rock.

Native vegetation.—The original timber growth consisted of maple, elm, beech, basswood, hickory, birch, with some hemlock, white and Norway pine.

*Present agricultural development.**—This soil is highly improved and probably over 75 per cent of it is under cultivation. Considering the extent of the type and its present development, it is the best and most highly improved soil in the area surveyed. The type of agriculture most extensively practiced consists of general farming, with dairying as the most important branch. The tendency at present is toward engaging more extensively in the dairy industry. The silo is in quite common use and more are being constructed each year.

The usual crops grown and yields secured are as follows: oats from 30 to 50 bushels per acre, timothy and clover hay from 1 to 2½ tons, and corn from 40 to 60 bushels per acre. While corn can be matured nearly every year except in the most northern occurrence of the type in Florence County, and while even here it matures during a large proportion of the seasons, a large part of the crop is grown for silage, of which a very excellent quality is produced. Potatoes are grown on a commercial scale in a few localities on this soil and yields from 200 to 250 bushels per acre are not at all uncommon. The light phase of the type is better adapted to potato growing

*For chemical composition and improvement see page 46.

than the heavy. Peas are grown for both seed and canning purposes, though on this soil mostly for seed. Sugar beets are grown to a limited extent and yields of from 12 to 15 tons per acre are secured. Alfalfa is being grown in a small way and yields of about 3 tons per acre are the average. Wheat is still grown by a number of farmers and as a rule the yields secured are satisfactory, ranging from 20 to 30 bushels per acre. A small amount of barley and some rye are also raised though not extensively in any section.

The rotation of crops most usually followed consists of corn, followed by oats, which may be followed by oats a second time, wheat, barley, or rye. If a grain crop does not follow the oats the field is seeded and hay is cut for the two following years, with possibly one year additional of pasturing before the field is again plowed for corn. The stable manure is usually applied to sod to be plowed for corn.

MIAMI LOAM*

Extent and distribution.—The Miami loam is confined chiefly to Little River, Lena, Oconto, and northern Stiles Townships in Oconto County, where it is the predominating soil. This same general tract extends north in southern Marinette County.

Description.—The surface soil of the Miami loam to an average depth of 10 to 12 inches consists of a brown or grayish brown loam. The surface soil rests upon a layer of lighter colored fine sand or fine sandy loam, which extends to a depth of 16 to 18 inches where a brown or reddish brown compact silty loam to clay loam carrying limestone gravel and rock fragments is encountered. This heavy material may extend to over 36 inches, though usually at 30 to 34 inches a yellowish fine sandy material containing a large amount of gravel and rock fragments is reached. In localities where the lighter material immediately below the soil is lacking the type frequently approaches a silty loam in texture. Below 30 inches a red clay is encountered in a few instances and here the soil approaches the Superior fine sandy loam—rolling phase. There is usually a sprinkling of gravel over the surface of this soil and stones and bowlders are sometimes plentiful upon the surface. A large proportion of the gravel, stones, and bowlders are of limestone. While stones are common, there are numerous areas that are practically stonefree.

Topography and drainage.—The surface of this type varies from undulating to very gently rolling. The slope is usually sufficient

*This type has been included with the fine sandy loam group of soils because it is quite similar to the Miami fine sandy loam. and will respond readily to the same methods of improvement.

to provide ample surface drainage, though the subsoil is sometimes sufficiently heavy to retard under drainage, so that over the lower portions of the type and on a number of the gentle slopes tile drains could be installed to advantage. The soil retains moisture very well and crops seldom suffer from drought except during the most severe dry periods.

Origin.—The material forming the Miami loam is derived from the calcareous glacial drift which covers the southeastern portion of the present survey.

Native vegetation.—The original timber growth was a mixture of pine, hardwood, and hemlock, the greater proportion being hardwood.

*Present agricultural development.**—A large proportion of this type is under cultivation. Very little timber is still standing. The type ranks as one of the best and most productive soils in the area surveyed. The crops grown are the same as on the Miami fine sandy loam, but the average yields frequently run a little higher. The acreage of potatoes is somewhat lower than on the fine sandy loam. The same methods of farming are followed and the same rotations practiced as on the Miami fine sandy loam, though the dairy industry appears to be somewhat more highly developed.

MIAMI FINE SANDY LOAM

Extent and distribution. The Miami fine sandy loam is one of the best, most important, and most highly developed soil types in the area. It appears as an extensive belt of country including a large part of southern Marinette, southern and southeastern Oconto, and southeastern Shawano Counties. Included with the typical Miami fine sandy loam are a number of phases, the most important of which has been indicated separately on the soil map as the poorly drained phase. The entire type covers an area of 452.7 square miles.

Description.—The surface soil of the Miami fine sandy loam consists of a brown or light brown friable sandy loam extending to an average depth of 10 to 12 inches. On drying the surface has a grayish appearance, which gradually becomes darker as the moisture content increases. Usually the amount of organic matter present is small, but in depressions where it has accumulated or where moisture conditions have been favorable for growth the surface soil frequently has a dark brown color. Immediately below the surface soil there is usually a yellow or yellowish brown loamy fine sand which extends to a depth of 18 to 20 inches, where it grades into a rather compact

*For chemical composition and improvement see page 46.

sticky sandy loam or gritty clay loam. This heavy material extends to a depth of from 26 to 30 inches, where unassorted glacial till is reached consisting of a yellow or yellowish brown sand or sandy loam with which is mixed varying amounts of gravel and stones. Stones and boulders are irregularly distributed over this type, though seldom in sufficient numbers to interfere with cultivation. Most of the stones have been removed from the improved land and used for building purposes, or as fences, or have been disposed of in piles about the farms. A considerable proportion of the gravel and boulders are limestone.

At a number of places, especially in Shawano County where the Miami fine sandy loam borders the Superior fine sandy loam—rolling phase, the surface soil is heavier than typical and frequently contains enough silt to be classed as a loam. The color of the subsoil is frequently a reddish brown and in places it is heavier than typical and extends to a greater depth. The line between the two types in Shawano County is usually an arbitrary one and small tracts of one soil have sometimes been mapped with the other. At Cecil and at various places in Washington and Waukechon Townships in Shawano County, the red subsoil can be found. In a few places it was found that the lighter colored and lighter textured layer immediately below the soil was not present. There are a few places throughout the type where gravel beds occur at or near the surface, but never over any extensive area.

The Miami fine sandy loam resembles the Superior fine sandy loam—rolling phase, and also the Kennan fine sandy loam in many respects. It differs from the Superior in the color and texture of the subsoil, the latter having a reddish or pinkish red subsoil, which is usually somewhat heavier than that of the Miami fine sandy loam. The Miami differs from the Kennan chiefly in containing a large amount of limestone material, while the latter contains none.

Topography and drainage.—The surface of the Miami fine sandy loam varies from gently rolling to rolling, with a few undulating tracts of rather limited extent. The slopes are usually quite long and gentle and upon some of these long slopes there are sometimes minor irregularities which tend to give the region a bumpy appearance, but such tracts are of small extent. No steep abrupt slopes are found, and modern farm machinery can be used over the entire soil type. Because of the lay of the surface and the gravelly nature of the subsoil, the natural drainage is excellent. While the subsoil is sufficiently heavy to retain moisture for growing crops, it is porous enough to permit the excess water from rains to percolate through and drain away.

Origin.—The material composing the Miami fine sandy loam has been derived from the weathering of glacial drift which is found here chiefly in the form of an extensive ground moraine. The greater proportion of the type is found overlying Lower Magnesian, Trenton, and Galena limestone, and the ground-up material from these formations has entered largely into the composition of the soil. The granitic boulders indicate that a portion of the drift must have been transported some distance from the north. The glacial ice carried the calcareous drift beyond the margin of the underlying limestone in places, so that soils of the Miami series are sometimes found over other formations than limestone.

Native vegetation.—Of the original timber maple, birch, beech, and hemlock were the most plentiful, though there was a generous supply of oak, elm, basswood, ash, and some hickory. Over most of the type there was only a scattering of white and some Norway pine, though in a few places of rather small extent pine was the predominating growth.

*Present agricultural development.**—A large proportion of the type is in improved farms and probably as much as 60 per cent is under cultivation. Dairying in conjunction with general farming is the leading type of agriculture followed. Quite a number of hogs are raised, especially on the farms engaged in dairying. Some beef cattle are raised, though feeding stock for the market has not been developed to prominence.

The crops grown and the yields obtained on this type of soil are: oats 30 to 45 bushels, barley 20 to 30 bushels, corn 35 to 50 bushels, peas 25 to 30 bushels, potatoes 125 to 200 bushels, and hay 1½ to 2½ tons per acre. Some sugar beets are grown and the yields range from 10 to 12 tons per acre. The quality of the grain grown on this type is very good. Wheat was grown to some extent a number of years ago, but has been largely abandoned. Peas are grown for canning as well as for seed. Potatoes are the most important cash crop and tubers of high quality are produced. Early varieties of corn will mature on practically all portions of the type, though early frosts frequently do some damage. Quite a large proportion of corn is cut for silage. Alfalfa can be successfully grown on this soil and some farmers have thrifty fields, though the total acreage is small.

More apples are grown on this soil than on any of the other types in the area and the fruit is of high quality. The soil is rich in lime, the subsoil is sufficiently open and porous to permit good root development, and the climate is such as to stimulate a vigorous sturdy growth of wood. The rolling character of the surface affords a large

*For chemical composition and improvement see page 46.

number of good orchard sites, and while the industry is not extensively developed at present, there are a number of commercial orchards, the success of which indicates that apple culture could profitably be extended to considerable proportions on this type of soil. The varieties most commonly grown here are Northwestern Greening, Wealthy, Grimes Golden, Snow, Red Astrakhan, and Duchess. Some small fruits such as strawberries and raspberries are grown, but none of these are produced on an extensive scale.

The question of rotation of crops best suited to this soil is being considered by the leading farmers and, while comparative tests have not been made on individual farms, various rotations have been tried in the different communities. The rotation most commonly followed consists of corn or potatoes, followed by a grain crop consisting of oats, barley, or rye, usually oats. Clover or a mixture of clover and timothy is seeded with the grain and hay is cut for 2 years, after which the field may be pastured a year before being again plowed for corn. The stable manure is most often applied to the sod to be plowed under for corn.

MIAMI FINE SANDY LOAM—POORLY DRAINED PHASE

The poorly drained phase of the Miami fine sandy loam is of comparatively small extent and is confined chiefly to Green Valley Township in Shawano County and to scattered areas in Oconto County chiefly in Morgan, Oconto Falls, Gillett, and Stiles Townships.

This phase represents those portions of the Miami fine sandy loam which are deficient in drainage throughout the greater proportion of their extent. The surface soil to a depth of 10 to 12 inches consists of a yellowish to grayish brown rather heavy fine sandy loam. This material rests upon a brown compact sandy clay which shows frequent mottling of gray and yellow. This heavy material may extend to a depth of over 36 inches, becoming more mottled with depth, or it may change gradually below 20 to 26 inches to a grayish yellow or gray sticky sand containing considerable gravel. Over the lowest portions of the type there is sometimes a shallow covering of Muck and Peat, but such areas are of very small extent. Where there is no Muck or Peat the surface soil is heavier than typical. Some stones and boulders are found on the surface.

The surface of the poorly drained phase varies from flat to undulating, with low ridges and marshy tracts so closely associated and occurring in such small areas that a separation could not be made between the low wet land and the higher lying soil in a genera^l

survey of this kind. Most of the tracts are so situated that open ditches and tile drains could be readily installed and the land thoroughly drained.

Only a very small proportion of this phase is improved, and where farms are in operation it is used chiefly for pasture or as hay land. Most of it is utilized in connection with better drained land, and in this way can be made of considerable value.

CHEMICAL COMPOSITION AND FERTILITY OF SUPERIOR FINE SANDY
LOAM—ROLLING PHASE, MIAMI LOAM, AND MIAMI FINE
SANDY LOAM

The texture and chemical composition of these types of soil are similar to those of the Kennan fine sandy loam described on page 32. The chief difference between the Miami and Superior soils on the one hand and the Kennan on the other is that the former have heavier subsoil which occasionally makes the under drainage less satisfactory, and they also have a considerable amount of lime carbonate in the subsoil as a result of their origin by glaciation either directly from limestone rock or, in the case of the Superior soils, from clays laid down in water containing calcareous material.

The same management and treatment so far as the use of fertilizers containing the mineral elements phosphorus and potassium and the importance of increasing the organic matter suggested in the discussion of the Kennan and Coloma fine sandy loams should be followed in the management of the Miami and Superior soils. The need of lime is much less general but acidity will be found to occur in patches.

CHAPTER IV

GROUP OF FINE SAND AND SANDY LOAM SOILS

PLAINFIELD FINE SAND

Extent and distribution.—The Plainfield fine sand is quite widely distributed and is found in four of the counties surveyed. With its poorly drained phase it has a total area of 144 square miles. In Shawano County this type is confined to the Wolf River Valley where it occurs bordering Shawano Lake. Another small tract lies along Embarrass River in Belle Plaine Township in Shawano County. In the Central part of Oconto County there are a number of tracts, the largest of which occurs along the Oconto River, both north and south of Suring. Large areas of the type occur in the southeastern corner of Marinette County and along the front of Green Bay in Oconto County, with small tracts in various other portions of the survey.

Description.—The surface soil to an average depth of 8 inches consists of a yellowish brown or grayish brown fine sand. The material is loose and open in structure, the organic matter content is low, and the soil is acid. The subsoil consists of a yellow fine sand to a depth of 18 to 24 inches, where it grades into a medium sand which in the lower depths of the 3-foot profile frequently contains a small amount of fine gravel.

Topography and drainage.—The surface of this type is level to very gently undulating, except in places where the wind has blown the fine sand into low dunes. In such places, which are of small extent, the surface is very gently rolling. On account of the loose open structure of the soil and subsoil, the natural drainage is thorough and usually excessive.

Origin.—Plainfield fine sand is an alluvial soil which was deposited as stream terraces, as outwash plains, or deltas built into the glacial lakes. The material was originally derived principally from sandstone rocks with smaller quantities of crystalline rock material. The southernmost tracts may have come in part from limestone till, but from this practically all lime carbonate has been removed by leaching. Since its first deposition, the surface has been modified slightly by the action of the wind.

Native vegetation.—The original timber growth consisted chiefly of white and Norway pine. Jack pine is scarce. The timber was all removed from this type years ago and at present there is an irregular growth of poplar, sand cherry, and white birch, with an under growth of sweet fern in a number of places.

*Present agricultural development.**—Large areas of Plainfield fine sand are not under cultivation, but near Oconto, Marinette, Crivitz, and Peshtigo it is utilized quite extensively. The crops chiefly grown are potatoes, rye, corn, buckwheat, beans, and hay. The yields average higher than those from Plainfield sand, and it may be considered a soil of fair agricultural value. By careful management profitable yields can be readily secured.

PLAINFIELD FINE SAND—POORLY DRAINED PHASE†

The poorly drained phase of the Plainfield fine sand is confined entirely to Oconto County in Morgan, Chase, Pensaukee, and Little Suamico Townships. The greater portion of this phase occurs as one continuous though somewhat irregular area. Most of it lies between the Pensaukee and Oconto Rivers, but a portion lies south of the Pensaukee.

The surface soil to an average depth of about 6 inches consists of a fine gray sand. In places the surface 1 or 2 inches has a brown or sometimes nearly black color, due to the presence of organic matter. The subsoil consists of a yellowish brown or rusty colored fine sand which is sometimes mottled with gray in the lower depths. The texture frequently becomes coarser with depth and at 30 to 36 inches a medium or even coarse sand may be found.

The surface is low and flat and, while a swampy condition does not prevail over the phase, it is all poorly drained and in its present condition has a low agricultural value. Scattered throughout the large area of this soil are small patches which have a shallow covering of peat, but all these were too small to be indicated. The original timber was chiefly white and Norway pine. At present the growth consists of poplar, birch, hazel, and willow.

SUPERIOR FINE SAND

Extent and distribution.—The Superior fine sand is of limited extent and occupies a total area of only about 12 square miles. The greater proportion is found in the southern part of Navarino and the

*At Crivitz in Marinette County the Wisconsin Experiment Station has secured very gratifying results with experiments on Plainfield fine sand. Reports covering this line of work can be secured by writing the College of Agriculture, Madison, Wisconsin.

†For chemical composition and improvement of Plainfield fine sand see page 57.

southwestern part of Lessor Townships in Shawano County. The type is associated chiefly with the Superior fine sandy loam.

Description.—The surface soil to an average depth of 10 inches consists of a light brown to slightly yellowish brown fine sand which contains only a small amount of organic matter in the surface 1 or 2 inches. The subsoil is a yellow or yellowish brown fine sand which extends to a depth of 24 to 30 inches where the sand is usually of a pinkish tinge. At a depth of from 36 to 48 inches heavy red clay may be encountered, though the depth to clay is variable.

In a number of places there are small sand dunes on this type, but wherever these were of sufficient size they were indicated on the map as Coloma fine sand. These usually occur where the depth of clay is greatest and the surface dries out thoroughly.

Topography and drainage.—The surface of the Superior fine sand is level. The heavy clay underlying the type has a tendency to hold up the water and there are times in the spring when the soil is too wet. Later in the season, however, the bed of clay is beneficial, as it acts as a reservoir and keeps a supply of moisture on hand for growing crops. There are a few places where open ditches or tile drains could be installed to advantage, though over much of the type fairly good crops could be grown without any drainage work being done.

Origin.—The heavy red clay underlying this soil is doubtless of lacustrine origin, having been deposited in quiet water, probably during an inter-glacial period. Most of it is confined to the Wolf River Valley and is lower than the surrounding country. The sandy covering was probably deposited during the invasion of the last ice sheet, or it may have been washed down from the higher land adjoining after the retreat of the last ice sheet. The heavy red clay is quite calcareous but over the sandy covering an acid condition has developed.

Native vegetation.—The original timber growth consisted chiefly of white and Norway pine, all of which has been cut. There is now a second growth consisting of poplar, birch, and hazel bushes and in the wettest places some willow.

*Present agricultural development.**—Only a very small proportion of this soil is under cultivation, the major portion of it having been left to itself after the timber was removed. Where farms have been started fair results are being obtained and corn, grass, and small grains are being raised successfully.

*For chemical composition and improvement see page 57.

PLAINFIELD SANDY LOAM

Extent and distribution.—The Plainfield sandy loam is of minor importance in the present survey, since it occupies a total area of only about 23 square miles. One of the largest tracts is found along the Embarrass River and Mill Creek in Belle Plaine and Herman Townships, Shawano County. Directly northeast of Antigo in Langlade County there is another area. Other small patches occur scattered over these two counties and also in Oconto and Florence Counties.

Description.—The surface of this type of soil to an average depth of 12 inches consists of a brown or light brown sandy loam of medium texture. In places the texture approaches that of a sand and could be classed as a loamy sand, but such variations are not extensive. The subsoil consists of a loose yellow sand which becomes somewhat coarser with depth and below 26 to 30 inches there is frequently some small water-worn gravel. In the lower layers this material is stratified.

Topography and drainage.—The surface of the Plainfield sandy loam is level to very gently undulating and because of the loose open character of the subsoil the natural drainage is good and somewhat excessive. Where the soil is under cultivation crops very frequently suffer from lack of moisture during some portion of practically every growing season. Where the type occupies a low terrace, as is sometimes the case, the water table is nearer the surface than typical and the soil is not so droughty.

Origin.—The Plainfield sandy loam consists of alluvial material which has been deposited as outwash plains or stream terraces. The parent material from which the type was derived consists partly of crystalline rocks, though there may also be varying amounts of material from sandstone. No traces of limestone are to be found and both soil and subsoil are in an acid condition.

Native vegetation.—The original timber growth consisted of white and Norway pine with varying amounts of birch, hemlock, and some maple. Jack pine is not found on this type. Over some portions of the type the hemlock predominated, while in other places the pine was the chief growth.

*Present agricultural development.**—Less than half of this land has been cleared and put under cultivation. Potatoes, small grain, and some corn silage are being grown. Yields are only moderate unless the soil is especially well handled.

*For chemical composition and improvement see page 57.

COLOMA SANDY LOAM

Extent and distribution.—The Coloma sandy loam is confined to Marinette and Oconto Counties where it occupies an area of approximately 72 square miles. It occurs as a somewhat irregular belt about 4 miles wide and extending to the southwest from the vicinity of Wausaukee in Marinette County to White Potato Lake in Brazeau Township in Oconto County. About 90 per cent of the type is in Marinette County.

Description.—The surface soil to an average depth of 10 inches consists of a light brown or grayish brown loose fine sandy loam, which in places gives way to a medium textured sandy loam. There is present only a comparatively small amount of organic matter, but there is sufficient fine material, consisting chiefly of silt, to impart a somewhat loamy character to the soil. The subsoil to a depth of about 24 inches consists of a light textured fine to medium sandy loam, which has a lighter color than the surface soil. At from 24 to 36 inches this grades into a light yellow medium sand. By far the greater proportion of the type is free from stones, and gravel is not found except in a very few spots.

This type very closely resembles the Vilas sandy loam but differs from that soil in having only a very few stones upon the surface, in having a somewhat less broken topography, and in having been derived largely from sandstone instead of in part from crystalline rocks.

Topography and drainage.—The surface of this type varies from gently rolling to rolling. The natural drainage of this soil is excellent. The internal drainage is somewhat excessive and the type is apt to suffer from drought during the latter portion of each growing season.

Origin.—The material composing the Coloma sandy loam consists of glacial debris which has been derived largely from the underlying Potsdam sandstone. It is probable that there is a small amount of material from the granitic rocks mixed with weathered sandstone material.

Native vegetation.—The timber growth on this type consisted of mixed pine and hardwood, but was made up most largely of white and Norway pine, with white birch, some beech, and red oak. Practically all of the merchantable timber has been removed.

Present agricultural development.—Only a very small proportion of this type has been redeemed from the cut-over stage and placed under cultivation. It is a fair soil and will produce reasonably good yields of all the general farm crops commonly grown in this region.

Observations in the field indicate that the average yields will probably range a little lower than for the Kennan fine sandy loam. It is not as productive a soil as the Miami fine sandy loam, but it is a type which can be successfully and profitably farmed.

COLOMA FINE SAND

Extent and distribution.—The Coloma fine sand comprises a total area of approximately 200 square miles. The largest tract occurs immediately north of Shawano Lake and east of the Wolf River in Shawano County, and in the southwestern part of Oconto County. The Coloma fine sand is also quite extensive in Marinette County and in the southern part of Oconto County where it is associated with the Miami fine sandy loam.

Description.—The surface soil of this type consists of a yellowish brown or grayish brown fine sand extending to an average depth of 8 inches. There is a very small amount of organic matter in the surface 2 or 3 inches of virgin soil but after a few years cultivation most of this is lost. The subsoil consists of a yellow loose fine sand. This becomes slightly lighter in color and somewhat coarser in texture with depth, until in the lower portion of the subsoil the material is a pale yellow medium sand. The type is practically stone free.

A variation from the typical soil which was included with the type is represented by long narrow winding ridges or eskers, which are locally known as "hog backs." On these ridges both soil and subsoil are often quite gravelly, and some of the gravel is limestone.

The Coloma fine sand corresponds very closely to the Kennan fine sand which occurs over crystalline rocks, and has practically the same texture, structure, and topography, but differs in that the Coloma has been derived largely from sandstone glacial till. The type as a whole is in an acid condition and contains very little lime carbonate, although the southern areas of this soil are closely associated with types of the Miami series which are not acid.

Topography and drainage.—The surface of the Coloma fine sand varies from undulating to gently rolling. In a number of places sand dunes have been formed, and where the cultivated fields are not kept covered with a growing crop the surface soil dries out quickly and is readily shifted by the wind. Growing crops are frequently damaged to a considerable extent by blowing sand. Owing to the topography of the type and the loose open character of both soil and subsoil the natural drainage is excessive.

Origin.—The material composing this soil consists of glacial debris which has been ground from the Potsdam sandstone by the

action of glacial ice. In some places, and especially along the northern border, there is a small amount of gravel present which indicates that some of the soil material may have been transported to this region from crystalline rock formations to the north and mixed with the sandstone material. About three-fourths of this type is underlain by Potsdam sandstone and one-fourth by limestone. It is probable that much of the material over the limestone has come from the sandstone region to the north. Where the parent material contained glacial limestone debris the soil has been leached to such an extent that practically all lime carbonate has been removed. Both phases have the same agricultural value and are therefore included in the same type.

Native vegetation.—The original timber growth consisted of scattered white and Norway pine with some localities which were covered entirely with Jack pine. In a few places there was found a growth of oak, but this was usually stunted and of little value. Fires have run over most of the type, and considerable tracts are so nearly cleared that it looks as though there had never been a forest growth. Sweet fern, blueberry bushes, scrub oak, white birch, and a little popple, with now and then a white, Norway, or Jack pine tree, make up the present growth.

*Present agricultural development.**—Probably about 8 per cent of the Coloma fine sand is under cultivation at present. The improved tracts are mostly on the portion of the type over limestone, where associated types are highly improved. The soil is of low agricultural value and returns from farms of this type are small. General farming is the kind of agriculture followed by most farmers on this soil, and the crops most commonly grown consist of potatoes, corn, rye, beans, hay, and some oats.

VILAS FINE SAND

Extent and distribution.—The Vilas fine sand is one of the extensive soil types in the area and covers approximately 475 square miles of which about one-half is found in Marinette County. Oconto, Florence, and Shawano Counties also contain from 50 to 100 square miles each. As is the case with other types of the area, this soil occurs in extensive irregular belts having a northeast and southwesterly direction. The type is closely associated with the Kennan fine sandy loam and the sandy soils of the Plainfield series.

Description.—The surface soil of the Vilas fine sand to an average depth of 9 to 10 inches consists of a loose yellowish brown fine sand.

*For chemical composition and improvement see page 57.

The surface inch on virgin areas is often a little darker due to a small accumulation of organic matter, but when the land has been burnt over, as is very often the case, the surface has a grayish appearance. The subsoil consists of a yellow fine sand which usually becomes somewhat coarser in texture and a little lighter in color with depth. The lower portion of the 3-foot section at times shows varying amounts of fine gravel and some stone. A moderate number of stones and boulders may be present upon the surface and mixed with the soil, though there are extensive areas which are stone free. There are fewer stones and boulders on this type than on the sandy loam of this series, but rock outcrops are more numerous than on any of the other types of the area. Extending through Oconto, Marinette, and into Florence County where this type occurs there is a series of extensive outcrops of granitic rocks. The outcrops are so large and so numerous that frequently areas as large as a square mile are of little or no agricultural value. The proportion of the entire type which is taken up in this way, however, is comparatively small.

A heavy phase of this type, consisting of a loamy fine sand, is found in Section 3, Town 33, Range 17, and in portions of Town 33 Range 16 in Oconto County. Similar areas also occur in Menomonee Indian Reservation in Shawano County, though none of them were found to be extensive.

Topography and drainage.—The surface of the Vilas fine sand varies from undulating to gently rolling with some areas that consist of low hills, giving a bumpy or hummocky appearance. The surface is not as rough and broken as the sandy loam of the same series. The slopes are usually long and gentle, so that from the standpoint of topography alone none of the type would be difficult to cultivate. Owing to the character of the surface and the loose open structure of the soil, the natural drainage is good and the under drainage is excessive.

Origin.—This type owes its origin to the weathering of glacial drift, some of which was derived from the grinding action of the ice sheet over the crystalline rocks of this region. A portion of the material probably came from the sandstone formation of northern Michigan. The type differs in this respect from the Coloma fine sand, which has been derived almost entirely from sandstone. There are no traces of limestone or limestone material in this type of soil and both soil and subsoil are found to be in an acid condition.

Native vegetation.—The original timber growth consisted of white and Norway pine with some Jack pine and scrub oak in a number of places. All of the valuable white and Norway pine has been removed and the present growth consists of small Norway pine, Jack pine,

scrub oak, and white birch. A few white pine trees are frequently seen but seldom any of the present merchantable value. Fires have run over large areas of this soil so frequently that in numerous places there is no tree growth.

*Present agricultural development.**—Probably not over 2 or 3 per cent of this type is under cultivation at present. In the vicinity of Florence, in Florence County, at Mountain and Breed in Oconto County, and at a few points in Marinette County there is more of this soil being farmed than elsewhere. The crops grown are corn, oats, peas, potatoes, and buckwheat. Yields are usually low. The cost of clearing this land is very small as compared with the cost of clearing any of the hardwood types.

VILAS SANDY LOAM

Extent and distribution.—The Vilas sandy loam is quite widely distributed over portions of five of the six counties included in the area, and comprises a total area of approximately 400 square miles. The largest tracts are found in Langlade and Forest Counties. Smaller irregular tracts are scattered through Oconto, western Florence, and central Shawano Counties.

Description.—The surface soil of this type to an average depth of 12 inches consists of a medium textured brown or slightly yellowish brown sandy loam which has a rather loose structure. When thoroughly dry it frequently has a grayish appearance, especially in cultivated fields where the amount of organic matter is smaller than in the virgin soil. The subsoil gradually becomes lighter in color and frequently coarser in texture, and below 22 inches it consists of an unstratified mixture of medium to coarse sand and fine gravel. Gravel frequently occurs scattered over the surface, though it is seldom very plentiful. Stones and boulders occur scattered over the surface and mixed with the soil material, but they are not as plentiful as on the Kennan silt loam. There are areas of varying sizes which are stone free.

A number of variations occur in the type and some of these are worthy of note. In Rolling Township in the southern part of Langlade County the soil is somewhat heavier than typical, is less rolling, has fewer stones, and taken as a whole is somewhat better for all agricultural purposes than the typical soil. Farming is better developed on this tract than elsewhere in the area. In the western part of Upham Township the type is more gravelly than usual and the texture is variable within short distances.

*For chemical composition and improvement see page 57.

Topography and drainage.—The surface of the Vilas sandy loam varies from gently rolling to rough and hilly. Over the major portion of the type the surface is not too steep for the growing of cultivated crops. In the extreme northern part of Forest County, in the northwestern part of Langlade County in Town 34, Range 9 (except in Sections 17 and 18 where the surface for one square mile is only gently undulating) and in the vicinity of Rose and Edith Lakes in Town 34, Range 14, the surface is very rough and the land has a low agricultural value. The surface frequently appears as a series of parallel ridges varying in elevation from 15 to 40 feet above the intervening valley bottoms and placed from 20 rods to $\frac{1}{4}$ mile apart.

On account of the uneven surface features of this type and the loose open structure of most of the material, the natural surface drainage is good, the under drainage is excessive, and the soil suffers from drought during a portion of nearly every growing season.

Origin.—The material composing the Vilas sandy loam consists of glacial debris which has been deposited by the ice sheet over the region of crystalline rocks, and which has been largely derived from the grinding up of this formation. A few eskers occur but these are of only limited extent, and the type as a whole consists of assorted and unassorted glacial till. It is not probable that any large portion of the material forming the soil has been transported a long distance, though sandstone formations to the north have contributed in part to its formation. There is no limestone in the region where this type occurs and both soil and subsoil are in an acid condition.

Native vegetation.—The original timber consisted of a mixed growth of pine, hemlock, maple, birch, and a little elm and basswood. In places, especially where the soil is lighter than typical, the pine was the predominating growth, while in the region where the soil is a sandy loam or heavier the maple and hemlock form the chief growth. Practically all of the pine has been cut as have also large tracts of hemlock and hardwood. There are, however extensive areas of this type which still support the virgin forest.

Present agricultural development.—Only a small proportion of this type is cleared and under cultivation at the present time, probably not more than 8 or 10 per cent. The proportion which is the most highly developed is that which occurs in Rolling Township in Langlade County. Rye, potatoes, corn, oats, and hay are the chief crops grown and fair yields are usually secured where improved methods are followed. Potatoes are the most important cash crop. The stony character of the soil, however, usually prevents the use of the potato digger and other improved machinery. The rotation most often followed consists of corn, or potatoes, rye or oats, followed by clover

and timothy. Dairying is being carried on to a limited extent and seems to be growing in favor. In other portions of the area surveyed, but little of this type is under cultivation except in small patches.

CHEMICAL COMPOSITION AND FERTILITY OF FINE SANDS AND SANDY LOAMS

These soils have intermediate texture and hence have moderate water-holding capacity. They are not fine enough to be especially well adapted to grasses for pasture, though a fair quality of pasturage can be secured on the heavier phases of these soils. The more deeply rooted crops, such as clover, rye, corn, and potatoes, find sufficient moisture during average seasons and suffer from drought only during periods of relatively low rainfall.

In chemical composition these soils are also of an intermediate character. The total phosphorus averages from 850 to 900 pounds in all types except the Vilas sandy loam which contains on an average about 1150 pounds in the surface 8 inches per acre, or from 25 to 40 per cent more than the other types. The total potassium of the surface 8 inches per acre is approximately 25,000 pounds or but little over one-half of that found in heavier soils such as the Kennan silt loam. The organic matter of these soils is also comparatively low, averaging from 2.5 to 3.0 per cent in the surface 8 inches and from 1 to 2 per cent in the second 8 inches. They have a correspondingly low nitrogen content averaging from a thousand to 1500 pounds in the surface 8 inches and from 500 to 800 pounds in the second 8 inches. This organic matter is largely in the form of leaf-mold and fine roots and is hence of an active character so that it decomposes quickly when the surface is first broken, furnishing a sufficient supply of nitrogen for a good growth of crops for a few years. It however, is exhausted with comparative readiness and the most important point in the management of all of these soils is to follow methods which will maintain and increase the organic matter. In the virgin condition these soils are but slightly acid as a rule, but with continued cropping the acidity increases and for the best growth of clover and especially alfalfa liming is essential. This use of lime not only makes the soil more suitable for the growth of alfalfa and clover but assists in preventing the leaching of phosphorus and maintaining it in a form which is available for growing crops.

The management of these soils to maintain the fertility will depend to a considerable extent on the crops grown and on whether or not stock is maintained to which the produce of the farm is fed. When

dairying or other live stock farming is practiced it will be less difficult to maintain the supply of the essential elements of plant food—phosphorus, potassium, and nitrogen. But even when stock is maintained it is very probable that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of stable manure should be made use of as far as practicable. The growth of a crop of soybeans or clover, occasionally, all of which is to be plowed under as a green manuring crop, will be found very profitable in its effect on the succeeding crop of corn or grain.

When these soils are used for the growing of potatoes or other special crops to a considerable extent the use of commercial fertilizers containing phosphorus and potassium will be found necessary to maintain the soil productivity. Clover or some other legume must be grown regularly in the rotation to maintain the nitrogen and organic matter, and part or all of this should be plowed under. It is often desirable to use the commercial fertilizers containing phosphorus and potassium in order to secure a good growth of this clover and there is little loss in so doing, since essentially all of the phosphorus and potassium applied to the soil for the clover becomes available to the succeeding crop through the decomposition of the organic matter.

The use of lime in some form and also the inoculation of the soil is of the utmost importance when alfalfa is to be grown and will be found helpful on the older fields even for the growth of medium red or mammoth clover.

While the use of commercial fertilizers containing phosphorus and potassium is desirable in the management of these soils it must not to be considered that this is an indication that they have less value, than heavier soils which are relatively higher in these elements, for the growth of potatoes and other special crops. The fact that these soils become dry and warm early in the season makes them less subject to local frosts and the finer tilth which these fine sands and sandy loams develop fit them especially well for the growth of potatoes and some other root crops, since they are practically free from checking and cracking. The cost of these fertilizers is a comparatively small part of the total cost of growing these crops. For further suggestions on the management of these soils and for information regarding source and use of fertilizers consult Bulletins 204 and 230 of the Experiment Station.

CHAPTER V.

GROUP OF SAND SOILS

COLOMA SAND

Extent and distribution.—The Coloma sand is a type of small extent and of minor importance in this area. It occupies a total area of approximately 10 square miles and is confined entirely to Shawano County. The greater proportion of this soil is found to the northwest of Shawano in Richmond Township.

Description.—The surface soil to an average depth of 8 inches consists of a light brown, loose sand of medium texture which contains only a very small amount of organic matter. The subsoil consists of a yellow medium sand which usually becomes coarser with depth and often lighter in color until at 30 to 36 inches the material is a coarse to medium sand of a pale yellow color. There may be some fine gravel present in the deep subsoil, but no gravel beds were found associated with this soil. There are a few granitic boulders upon the surface and in places a small amount of gravel.

Topography and drainage.—The surface of the Coloma sand varies from gently rolling to rolling, and a few areas have been included where the surface is undulating. On account of the surface features and the loose open structure of the material, the drainage is excessive and the type is droughty.

Origin.—The material composing this type consists of glacial debris which has been derived chiefly from the grinding off of the underlying Potsdam sandstone by the glacial ice sheet. The presence of a few granitic boulders and gravel indicates that there is probably a small amount of material from the region over the granitic rocks that has been carried from the north and mixed with the broken down sandstone. There is no trace of limestone in this type and both soil and subsoil are in an acid condition.

Native vegetation.—The original timber growth consisted chiefly of white and some Norway pine. In places there was a little oak but the growth was stunted. All of the merchantable timber has been removed and the greater portion of the type is now in stumps. In places there is a second growth of white birch and poplar. Sweet fern is also common over most of the type.

*Present agricultural development.**—Not over 15 per cent of this type is under cultivation. The soil has a low agricultural value. The crops most commonly grown are potatoes, corn, rye, oats, and a little hay.

VILAS SAND

Extent and distribution.—The Vilas sand is of limited extent, of minor importance, and occupies only about 16 square miles in the area surveyed. A few small tracts are found in Elcho Township in Langlade County, in the northwestern corner of Oconto County around Boot Lake, and in Pella, Herman, Fairbanks, and Germania Townships in Shawano County.

Description.—The surface soil consists of a light brown medium sand which extends to an average depth of 8 inches. The material is loose and open in structure, contains only a small amount of organic matter and is in an acid condition. The subsoil consists of a yellow medium sand which becomes slightly coarser with depth and often somewhat lighter in color. Some fine gravel may occur in the deep subsoil and occasionally there is a small amount scattered over the surface. A few stones may also be present upon the surface, but never in such numbers as to interfere with cultivation.

Topography and drainage.—The surface of the type is gently rolling for the most part with some portions which are hilly. Owing to the rough topography and the loose open character of the soil and subsoil the natural surface drainage is excessive as is also the under-drainage, and the type suffers from lack of moisture during practically every season.

Origin.—The material composing this type consists of glacial debris which has been ground in part from the underlying crystalline rock, but not transported for any great distance. Sandstone formations to the north have also doubtless contributed to the formation of this soil. There is no limestone material present and both soil and subsoil are in an acid condition.

Native vegetation.—The original timber consisted chiefly of white and Norway pine with Jack pine in places and an occasional scattering of hardwood, though the hardwood was never plentiful.

Present agricultural development.†—Only a very small proportion of this soil is cleared and under cultivation at present and because of its low agricultural value it is not at all probable that it will be improved rapidly, except portions of the type which are the most favorably located. The portion of this soil in the vicinity of Tigerton

*For chemical composition and improvement of Coloma sand see page 64.

†Chemical composition and improvement of Vilas sand will be found on page 64.

in Shawano County is somewhat better than the average and some very satisfactory crops are being grown there. Corn, rye, potatoes, clover, beans, and oats are the chief crops.

VILAS STONY SAND

Extent and distribution.—Vilas stony sand occupies a total area of about 70 square miles and is a type of minor importance. It has a lower agricultural value than any of the other upland soils of the area surveyed. The largest tract is found in northern and northwestern Forest County and in the western half of Florence County, chiefly along the Popple River to the northwest of Fence. There is also some of this type in northern Oconto County and small patches occur in the northern part of Langlade County along the Wolf River and in southwestern Shawano County chiefly in Germania and Fairbanks Townships.

Description.—The surface soil of this type to an average depth of 8 to 10 inches consists of a yellowish brown or yellow loose medium sand. The surface 1 or 2 inches frequently has a grayish color. The amount of organic matter present is very small. The subsoil consists of a loose yellow sand which becomes coarser with depth and usually somewhat lighter in color. Gravel also occurs in the subsoil and the amount of it usually increases until at from 2 to 3 feet the material frequently consists of a coarse gravelly sand. Stones are very plentiful upon the surface and some large bowlders are also found. On many of the ridges and hill tops gravel occurs at the surface. The stones and bowlders are sometimes so plentiful as to justify calling this "rough stony land."

Topography and drainage.—The surface of this type varies from rolling to bumpy and choppy. Kames and eskers make up a considerable proportion of the type and the surface is everywhere very irregular and broken. Long narrow gravelly ridges frequently alternate with a series of rounded steep hills and leave the surface in such a condition that even though the soil were heavy the topography is such as to give it a very low agricultural value. The surface is so irregular and the soil so open and porous that the natural drainage is excessive and the type very droughty.

Origin.—The material composing the stony sand consists of glacial debris which has been deposited as kames, eskers, and probably as lateral and recessional moraines. The glacial drift was doubtless derived in part from the underlying crystalline rocks through the grinding action of the glacial ice sheet and also from sandstone forma-

tions to the north. The gravel, stones, and boulders are largely of crystalline rocks.

Native vegetation.—The original timber growth consisted chiefly of white, Norway, and Jack pine. There are a few tracts of limited extent where some hemlock and a little maple grew, but in these localities the topography was so rough and the surface so stony that the agricultural value was considered no greater than the average of the type.

*Present agricultural development.**—On account of the loose droughty nature of this soil, its stony bowldery surface, and its uneven broken topography, the type has very little value for agricultural purposes and much of it may well be considered a non-agricultural soil.

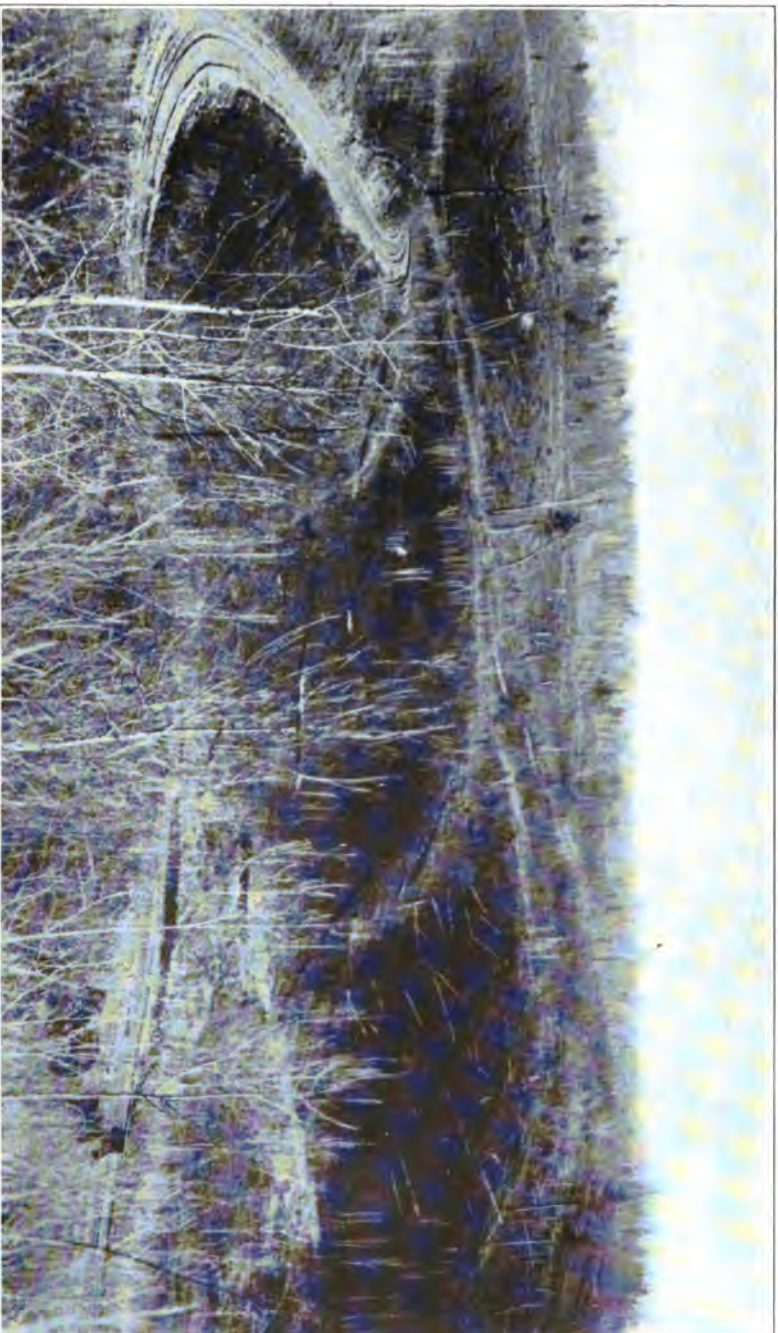
PLAINFIELD SAND

Extent and distribution.—The Plainfield sand occurs in five of the six counties included in this area and covers a total area of about 285 square miles, of which about 225 square miles are found in Marinette County. In Florence County none of this type was mapped.

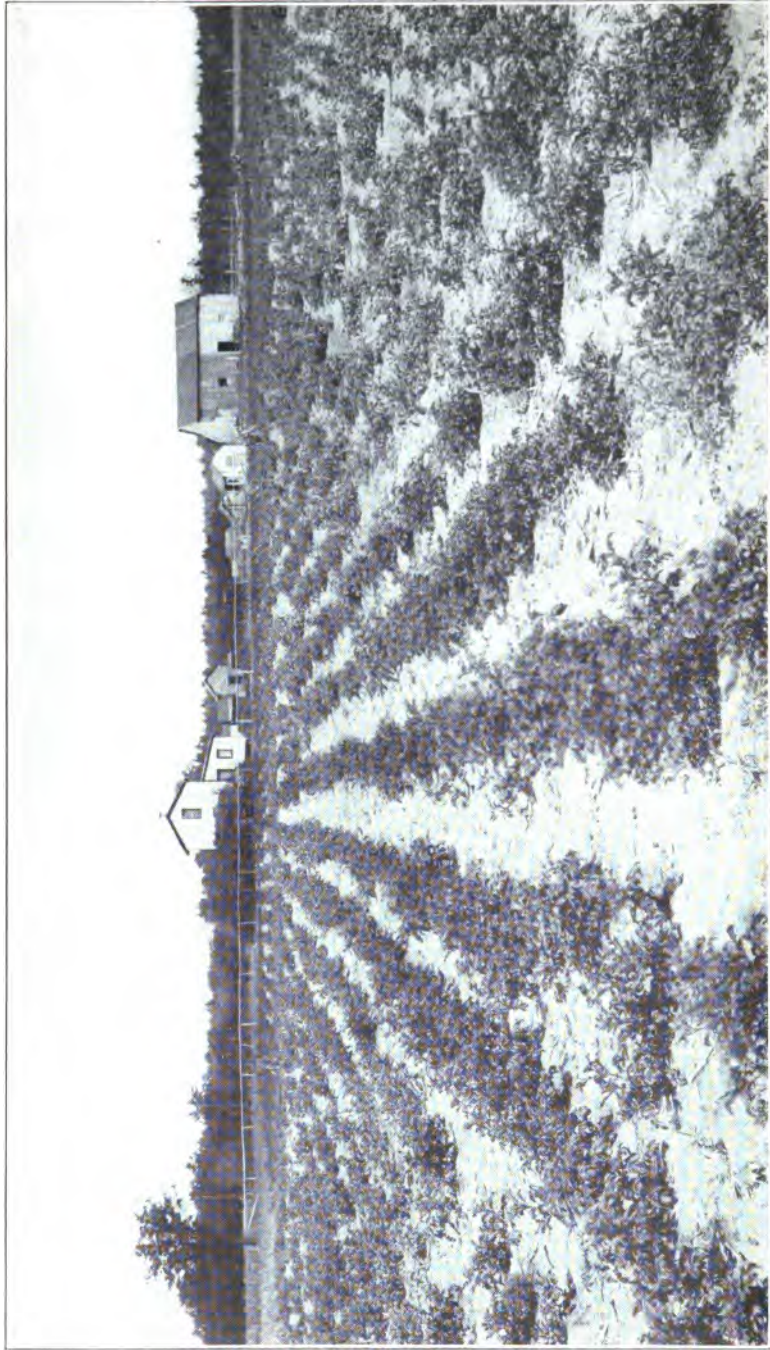
Description.—The surface soil of the Plainfield sand to an average depth of 8 inches consists of a light colored, yellowish brown, or grayish brown loose sand of medium texture. In the virgin soil there is frequently a slight accumulation of organic matter in the upper few inches, but after a few years of cultivation under the usual methods this largely disappears. The subsoil consists of a yellow, yellowish brown, or grayish brown loose sand of medium texture which usually becomes somewhat lighter in color and coarser in texture with depth. Below 24 to 30 inches there is often a considerable proportion of coarse sand and some fine well rounded gravel. Litmus paper tests and the nature of the vegetation indicate an acid condition of both the soil and subsoil.

A quite common variation in this type occurs where the surface soil is a coarse sand. There are a number of such tracts in Marinette County, and the area south of Mountain, in Oconto County, is of this character. A texture slightly finer than that of the typical soil is another phase of the Plainfield sand. This is found in various parts of Marinette County. It is largely confined to regions where the surface is uneven and the material probably of wind-blown origin. Eskers containing large quantities of gravel are also found in Marinette County, but their total area is very small. Throughout northern Marinette County and in other localities where the underlying formation consists of crystalline rocks there are a number of rock

*For chemical composition and improvement see page 64.



VIEW SHOWING ROUGH, MORAINIC CHARACTER OF VILAS SAND AND VILAS STONY SAND.
These types of soil have a low agricultural value, and present conditions seldom favor their improvement.



VIEW SHOWING SURFACE FEATURES CHARACTERISTIC OF PLAINFIELD SAND.

The level surface is also typical of Plainfield fine sand, but as the sand type has a coarser texture it is not equal to the fine sand in producing power. Plainfield sand requires careful management.

outcrops and a few boulders scattered through many of the areas of Plainfield sand, though the type as a whole is free from stones and boulders. Where the underlying rock is sandstone there are no outcrops and very few boulders.

The Plainfield sand is locally known by such terms as "sandy land," "Jack-pine land," or "sand plains."

Topography and drainage.—The surface of the Plainfield sand where typically developed is level to very gently undulating. In Marinette County there is more variation in the surface than elsewhere, and to the southeast of High Falls wind-formed dunes occur in such numbers as to impart a somewhat rolling surface. This same condition exists in other parts of the county, though to a smaller extent. Eskers and kames have been included with the type in a few instances, as none of these areas are more than a few acres in extent. On account of the loose open structure of the Plainfield sand the natural drainage is ample and very often excessive, so that field crops frequently suffer from lack of moisture.

Origin.—The Plainfield sand, where typically developed, consists of alluvial material which has been deposited as stream terraces, valley fill, or outwash plains. The greater portion of the material was doubtless deposited during the advance and retreat of the last ice sheet which covered this region. The few kames and eskers which occur were deposited beneath the ice sheet, while most of the other irregularities in the surface, such as the dunes, are due to the action of the wind. The gravel present in the subsoil and the boulders which occur over small areas are largely composed of crystalline rocks. These with the Potsdam sandstone make up the underlying formation and the parent material came largely from these sources. In a few instances limestone is the underlying formation, but it has no appreciable influence on the soil.

Native vegetation.—The original timber consisted chiefly of Jack pine, which is the characteristic growth on this type, with some scrub oak and occasionally a little Norway and white pine. As an undergrowth the land is usually covered with sweet fern, blueberry bushes, and wild oat-grass.

Present agricultural development.—Only a small proportion of the Plainfield sand is under cultivation at present, but land is being cleared each year and new farms started. The type of agriculture most common consists of general farming, with potato growing and dairying as important branches. The chief crops grown are oats, rye, buckwheat, hay, potatoes, peas, beans, and corn. Average yields are low. Only a small quantity of corn is grown and most of it is cut for silage. The type is well adapted to truck crops. The rotation most

commonly followed consists of corn, potatoes, and oats or rye, followed by a hay crop, usually timothy and clover mixed. What manure is produced on the farm is most frequently applied to sod land to be plowed for potatoes or corn.

CHEMICAL COMPOSITION AND FERTILITY OF COLOMA, VILAS, AND PLAINFIELD SANDS

In some respects sandy soils have advantages over heavier soils. They become drier and therefore warmer and can be worked earlier in the spring and more quickly after rains than heavier soils. These advantages are particularly important in regions of short growing periods. But when the soil is too sandy it does not hold sufficient water from one rainfall to another to satisfy the needs of the growing crops and they therefore suffer from drought. Moreover, some sandy soils are lower in their supply of the chemical elements demanded by crops than heavier soils. When these two factors become too low they limit the profitable farming of these soils. In the mapping of the Soil Survey those soils which are classed as fine sands or sandy loams have fairly good water-holding capacity and when their fertility is properly maintained their good qualities in regard to warmth and earliness can be taken advantage of and they can be farmed with profit. But soils which are classified as sands, such as the Coloma, Vilas, and Plainfield sands are so coarse as a rule that they do not have sufficient water-holding capacity and their use for the growth of staple crops is ordinarily unprofitable, unless unusual skill is used in their management. It must be kept distinctly in mind, however, that all types as mapped show some variation in texture or fineness of grain and that on small portions of soils mapped as sands a more detailed mapping would have shown fine sands. This is particularly true in the case of sands mapped as Plainfield sand in Marinette County which was surveyed several years before the remainder of this area was mapped. The discussion of the composition and agricultural value of fine sands will be found on page 57. With very unimportant exceptions, the soils mapped as Coloma, Vilas, and Plainfield sands in this area are of a very sandy character and profitable farming will be possible on them only when they are managed with unusual care and the crops to which they are best adapted are grown. The chief factor limiting their agricultural use is that of water-holding capacity. This depends chiefly on the texture or fineness of grain and cannot be affected by any treatment it is practicable to give them. The water-holding capacity can be somewhat increased by increasing the amount of organic matter, but this is a comparative-

ly slow process and the amount of organic matter it is practicable to develop and maintain in these soils will increase their water-holding capacity only to a limited extent.

The total content of the essential elements of plant food in these soils is moderate. The total phosphorus in the surface 8 inches per acre averages between 1000 and 1100 pounds and in the second 8 inches between 600 and 700 pounds. The total potassium in the surface 8 inches per acre is approximately 35,000 pounds in comparison with 50,000 or 55,000 pounds in the silt loam soils of that region. The total nitrogen content is between 1200 and 1400 pounds in the surface 8 inches per acre. When a sufficient supply of active organic matter is developed in these soils a considerable portion of the phosphorus and potassium will undoubtedly be made available, but the use of fertilizers containing these elements in a more readily available form is desirable whenever these soils are farmed.

The starting point in the improvement of these soils is the development of active organic matter through the growth of legumes which are able to secure their nitrogen supply from the atmosphere. The growth of a good crop of mammoth clover or soybeans through the use of mineral fertilizers containing phosphorus and potassium is the best means of supplying this nitrogen and organic matter. This crop should be plowed under as a green manuring crop. Ordinarily on these soils clover should be sown without a nurse crop. It should also be put in a little deeper than on heavier soils and the drill should be followed by a roller and finally the drag or corrugated roller should be used.

By the adoption of a rotation of crops including one year in four in which a legume crop is grown and the entire crop plowed under and the use of moderate amounts of commercial fertilizers containing phosphorus and potassium together with proper attention to cultivation to conserve moisture, fair crops can be grown during the remaining three years. When dairying or other line of stock farming is followed so that most of the crops grown aside from the green manuring crop are fed, the fertility of this land can be maintained. This will permit the growth of potatoes or other truck crops for direct sale on approximately one-eighth of the land on the farm.*

*Extensive experiments have been carried on on Plainfield sand near Sparta, information on which may be secured by writing to the Soils Department, of the Wisconsin Experiment Station.

CHAPTER VI

GROUP OF POORLY DRAINED SOILS

CLYDE LOAM

Extent and distribution.—The Clyde loam is one of the least important types in the area from the standpoint of acreage. It occupies 9.4 square miles and is confined to a portion of the area underlain by limestone. The type usually occurs in long narrow strips along stream courses, or in depressions where a marshy condition is approached.

Description.—The surface soil of the Clyde loam to an average depth of 12 inches consists of a very dark or black loam which contains a high percentage of organic matter. Frequently small areas occur which have a shallow covering of peat. The subsoil consists of a gray or bluish material of variable texture. The upper subsoil may be clay loam or a loam which becomes lighter in texture with depth, grading into a gritty and somewhat sandy loam at 18 to 24 inches. The deep subsoil is often mottled with yellow or reddish iron stains.

Topography and drainage.—The position of the Clyde loam is always low and it is naturally poorly drained. It is level to very gently sloping.

Origin.—The Clyde loam is partly alluvial and probably partly lacustrine in origin. On account of the calcareous nature of the subsoils of most of the upland types in this portion of the area and the leaching which has taken place, large quantities of lime carbonate have been carried into these low-lying places.

Native vegetation.—The original timber growth consisted chiefly of elm, ash, and soft maple, with some willow. All of the best timber has been removed, but there is still much willow and a number of larger trees of second quality.

*Present agricultural development.**—Only a very small proportion of the Clyde loam has been cleared and put under cultivation. In its present condition this type has a low value, but when drained and properly farmed its productivity will doubtless be equal to that of any other soil in the area.

*For chemical composition and improvement see page 68.

POYGAN FINE SANDY LOAM

Extent and distribution.—The Poygan fine sandy loam as mapped in the present survey is confined to one area of about 15 square miles in the extreme southeastern corner of Oconto County. It occurs in a belt about 2 miles wide bordering Green Bay and extends from the southeastern corner of the county northward for a distance of 8 miles.

Description.—The surface soil to an average depth of 8 inches consists of a dark gray or almost black fine sandy loam. The dark color is due to the content of organic matter, which is quite variable.

The subsoil consists of a light gray fine sand which extends to a depth of from 24 to 30 inches where a pinkish red clay is usually encountered. In some localities where drainage is the most defective the clay has a bluish color but the texture is the same. The depth to the clay is quite variable and sometimes is below the reach of the soil auger. In a few places the clay comes to within 12 to 16 inches of the surface.

Topography and drainage.—The surface of the Poygan fine sandy loam is low and very nearly level. There is only a very gentle slope toward Green Bay but this is usually sufficient to afford the necessary fall for open drainage ditches or tile drains. Owing to the level surface and its low position the natural drainage is deficient.

Origin.—The clay subsoil underlying the Poygan fine sandy loam is doubtless of lacustrine origin. The fine sand and fine sandy loam covering over the clay has probably been washed down from the higher lands adjoining and deposited over the clay. There is a very sandy low ridge running parallel with the shore about 1 mile inland and this appears to be an old beach line. The clay subsoil is highly calcareous, but the dark surface soil shows slight indication of acidity in places.

Native vegetation.—The original timber growth consisted chiefly of elm and ash, with a considerable growth of willow.

Present agricultural development.—Probably 50 per cent of this soil has been cleared and a number of farms are now in operation upon it. Fully half of the cleared portion is used for cutting wild hay. A number of open ditches have been constructed but a much more extensive drainage system must be installed before the type as a whole can be utilized for cultivated crops. Corn, oats, and hay are the chief cultivated crops grown. A small amount of buckwheat, some potatoes, and garden truck are also raised.

CHEMICAL COMPOSITION AND FERTILITY OF CLYDE LOAM AND POYGAN
FINE SANDY LOAM

These two types of soil are well balanced in chemical composition. Both have a good supply of organic matter and as a rule both contain considerable lime carbonate at least in the subsoil. Their total content of the elements phosphorus and potassium is also nearly if not quite as large as that found in most upland soils of a good degree of fertility. As a result these soils are usually quite fertile and productive. They are relatively flat, however, and the presence of rather heavy subsoil for the most part renders drainage often unsatisfactory making the use of tile or open ditches necessary.

The organic matter found in these soils while usually of sufficient quantity, is not all of an active character and it is frequently found in the continued cropping of soils of this kind that while it still retains sufficient organic matter to give it a strong dark color, this material is rather inert and does not decompose readily. Furthermore, it is quite possible that it protects the rock grains of the soil from the decomposing action of the soil moisture so that the mineral elements phosphorus and potassium do not become available as readily as they otherwise would. When these soils begin to lose fertility as indicated by lessening yields and good drainage has already been provided the owner should determine whether they do not need a larger supply of active phosphorus and potassium as well as of active organic matter. The use especially of potash fertilizers on these soils is frequently very helpful. Frequently patches of from a few square rods to several acres are met on which some crops, especially corn, make very unsatisfactory growth and the use of potash fertilizers is often found to increase the yield on these patches to a very satisfactory point. Wood ashes can be used as a potash fertilizer as well as the standard forms.

PEAT

Peat is found in every county in the area and in tracts ranging in size from a few acres to over 25 square miles. The most extensive tract occurs along Peshtigo Brook, in northeastern Oconto County. Other large areas occur in the southeastern part of Marinette County and in Navarino Township, in Shawano County. In northern Forest County there is also considerable Peat.

The material mapped as Peat consists of vegetable matter in various stages of decomposition. Much of the material is still in a very raw, fibrous condition, showing plainly the remains of vegetable

growth from which derived. This raw, fibrous material is of a brown color, but the more thoroughly decomposed it becomes the darker is the color. Small quantities of mineral matter may be incorporated with the organic matter, but when this becomes sufficient to change the texture appreciably, the material is classed as Muck. In the extensive areas of Peat little or no mineral matter is found, except about the margins, where there is frequently sufficient inorganic matter present to form Muck. In such places where the area of Muck was small it was included with the Peat. A number of the large areas mapped as Muck in an earlier survey of Marinette County would under the present classification be mapped as Peat.

The depth of Peat is variable and ranges from 10 inches to over 20 feet. In practically all of the swamps where the area is a square mile or more in extent the Peat is over 3 feet deep. In many of the smaller patches there is a margin of several rods where the underlying material can be reached at 12 to 20 inches, while in the center of the marsh it will be over 3 feet below the surface. In some of these places, however, the entire tract is shallow, but when the average depth is 18 inches or over it has been mapped as Peat.

The material underlying the Peat is variable, and ranges from sand to silt loam or clay loam. In general it may be stated that the texture of the underlying material is determined largely by the texture of the upland soil in the vicinity of the Peat areas. Throughout the areas of silt loam the underlying material is unusually heavy and of a light gray or bluish color. Throughout the sandy portions of the area Peat is underlain by a grayish or nearly white fine to medium sand, and in some instances there is considerable gravel mixed with the sand. One marshy area in northern Forest County was found to be underlain by a bed of marl. The surface of practically all of the Peat areas is level. Most of the Peat areas are wet for the greater part of the year and there is often a few inches of water over the surface in the spring, when most of the heavy rains occur. There are a large number of the Peat marshes which lie on a sufficient slope to enable them to be successfully drained. In fact, it seems very probable that far the greater proportion of the Peat in the area is so situated as to permit of drainage. Up to the present time, however, only a very small proportion of it has been reclaimed. About 2 miles west of Marinette a number of farmers have formed a drainage district, and have drained a large area of Peat with a deep canal. Aside from the above mentioned tract, only a few small tracts on individual farms have been drained and placed under cultivation.

The vegetation on the areas of Peat consists chiefly of tamarack, cedar, and spruce. On the shallow areas there is some ash and a little

soft maple. There are a number of marshes which at present either do not support any timber or have only a scattering growth of spruce or tamarack. In most of these places the original timber has been completely destroyed by fire, though there are a few marshes which it seems were always treeless. On some of the open marshes there is now a growth of coarse grass which is cut for hay or matting, though in the majority of cases the vegetation consists of sphagnum moss, cranberry bushes, and other moisture-loving plants.

CHEMICAL COMPOSITION AND FERTILITY OF PEAT

Throughout the southeastern portion of the area, where limestone is the underlying rock formation and where the subsoils of the upland types are calcareous, Peat is seldom in an acid condition, or is only slightly acid, but in the region where the underlying formation consists of sandstone or crystalline rocks and the soils are made up entirely of noncalcareous material it is practically all very acid.

The chief difference between peat soils and upland soils, consisting largely of earthy matter, is that they have relatively small amounts of the mineral elements phosphorus, potassium, calcium, and magnesium; and have extremely high amounts of nitrogen in the organic matter. The average per cent of phosphorus in the peats of this region so far analyzed is .135 per cent. This means that in an acre of the soil to a depth of a foot there is approximately only 675 pounds or in 2 feet 1350 pounds in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorus less available than in non-acid soils.

The deficiency of potassium in these soils is greater than that of phosphorus. They contain on the average .3 per cent of this element, while good upland clay loam soils average 2 per cent or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account it will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about .12 per cent and this only in the surface 8 inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment requires the use of fertilizers containing especially the elements phosphorus and po-

tassium. Of course, these elements are contained in relatively small amounts in barnyard manure and good applications of manure will secure good yields of crops on the peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well as peat, the manure should be used on the upland soils and commercial fertilizers, phosphorus, and potassium used on the peat land.

On the deeper peats which are in a very raw and acid condition the use of lime in some form in addition to the commercial fertilizers will be found profitable. Occasionally a marsh is found on which on account of coldness and high acidity at first nitrification or the chemical change by which the nitrogen in the organic matter becomes available to crops does not take place readily and the use of a light application of composted stable manure to inoculate the soil with the proper organisms is very helpful.

When thoroughly drained and properly managed with reference to fertilizers as above outlined, peat lands can be made to produce good crops of the kinds to which they are adapted. In the southeastern portion of this area where the temperature conditions are favorable these lands may be used for such crops as corn, potatoes, and sugar beets, as well as others not affected by light frost such as grasses for hay and small grains. In the northern portion where the altitude is greater and the liability to summer frost is greater, it will probably not be found practicable to use this land to any considerable extent except for the growing of grass for hay and crops not affected by frosts such as some of the root crops and small grains.

MUCK

The material mapped as Muck occurs in four of the six counties of the present survey, and while its extent is greater than that of several minor upland types, it is much less than that of the Peat. The greater proportion of the Muck is found in Marinette County, where it occupies over 175 square miles. The most extensive occurrence in this county is immediately to the south of the Wausaukee River and to the east of Lake Nocque Bay. In the southwestern corner of the county there is a tract of considerable size along Peshigo Brook and in the southeastern portion a larger tract extends to the northeastern corner of Oconto County. Other tracts occur throughout Marinette, Oconto, Shawano, and Langlade Counties, chiefly as narrow belts of low land along streams rather than as extensive marshy areas.

Where most typically developed the Muck consists of black well decomposed organic matter with which there is incorporated an

appreciable amount of mineral matter. In Marinette County this material extends to a depth of from 3 to over 5 feet in a number of the larger tracts, but in the majority of areas, which are long and narrow, the depth is usually less than 3 feet. The material included as Muck is variable, and it includes a number of small tracts which in a detailed survey would be classed as Meadow and doubtless also a number of small tracts of Peat. The meadow consists of low wet land along streams where the texture of the soil is so variable as to make a textural classification impossible.

Throughout the southeastern portion of the survey, where the underlying rock is limestone, the soil is not sour. In the portion of the survey underlain by sandstone and crystalline rocks, where the soils are all non-calcareous, the Muck is very sour.

Where the Muck is deepest the timber growth consists of cedar and tamarack, with soft maple, ash, alder, elm, and some willow where it is shallow. Some of the low wet lands included with Muck are treeless and are called "hay marshes."

Only a few patches of Muck are under cultivation, but when drained thoroughly and properly managed it will produce profitable crops of corn, potatoes, cabbage, buckwheat, and timothy and alsike clover for hay. Small grains may also be successfully grown. Tame grass pastures can be developed on these Muck areas with proper care. Muck is rich in organic matter and nitrogen, but requires applications of potash and phosphorous in the form of commercial fertilizers to keep up the productiveness. Its need for potassium is not so great as that of the Peat. In other respects it is similar to Peat, for the discussion of which the reader is referred to page 68.

ROCK OUTCROP

There are a few local areas in the present survey where ledges of the underlying rock outcrop in sufficient numbers to make such areas practically worthless for agricultural purposes. Wherever outcrops of any important extent occur they have been indicated on the soil map by means of appropriate symbols.

The most extensive and numerous outcrops occur in a belt running from the northeast portion of Marinette County to the vicinity of Mountain in Oconto County, and these are associated with the Vilas fine sand and fine sandy loam types of soil more extensively than with any of the other soils of the area. Other ledges occur quite frequently in southwestern Shawano County and along the Wolf River in northern Shawano and eastern Langlade County. Practically all of the rock exposures are confined to the region where granitic rocks make up the underlying formation.

CHAPTER VII

GENERAL AGRICULTURE

Agricultural Development.—Agricultural operations were not well under way in this region until in the 70's, and farming could not be considered of very much importance until in the early 80's. By this time considerable timber had been removed from southern Marinette, Oconto, and southeastern Shawano Counties and substantial farming communities were established. The first homestead in Langlade County was taken up in 1875, and a settlement was made at Phlox in 1876 and 77. Lumbering operations were extensively carried on in the immediate vicinity of Antigo during the 80's and 90's, and farming followed rapidly upon the trail of the lumbermen.

Extensive and highly improved farming communities are now to be found in western and southern Langlade, southern and southeastern Shawano, southern and southeastern Oconto, and southern Marinette Counties. Between this condition and the extensive tracts of virgin forest and undeveloped cut-over lands throughout the northern portion of the area surveyed, all stages of agricultural development may be found.

At the present time the type of agriculture which is the most extensively practiced consists of general farming in conjunction with dairying, with hay and oats as important cash crops. In the newly developing communities potatoes are an important cash crop. A larger proportion of Shawano County is cleared and under cultivation than is the case with any of the other counties in the survey.

Chief Crops Grown.—The crops most extensively grown in this region in order of their respective acreage are hay, oats, corn, barley, potatoes, rye, wheat, and peas. Yields of from 2 to 2½ tons of timothy and clover are very common on the best soils of the area. Alfalfa can be successfully grown and the acreage is gradually increasing. Where the soils are in an acid condition liming is necessary and the soil should be inoculated.

Oats is grown more extensively than any other grain crop. The average yield per acre for 1909 for all kinds of soils was about 31 bushels. The yields on the light sandy soils, which are poorly adapted to oats, were very low, but on the soils as heavy as fine sandy loams or heavier, the yields were very satisfactory. Yields of 50 bushels per acre are very common.

Statistics show that corn is the third crop in importance from the standpoint of acreage. As dairying increases the number of silos also increases. This calls for an increased acreage of corn. Golden Glow, Wisconsin No. 12, and Wisconsin No. 8 are early dent varieties which are being grown successfully in addition to the native yellow dent corn of mixed breeding. Flint corn is also quite commonly grown. Throughout the southern portion of the area the dent varieties mentioned above will mature four years out of five.

Barley is the second small grain crop of importance. It is raised most extensively in Shawano, Oconto, and Langlade Counties, and during 1909 the total acreage in these three counties was over 15,000 acres, which produced an average yield of slightly over 25 bushels per acre. The yields on the light soils are low, but on the Antigo silt loam, rolling phase of the Superior fine sandy loam, and Miami fine sandy loam types yields of 35 bushels per acre are quite common.

Rye is grown to a limited extent. The average yield on all kinds of soils was about 15 bushels per acre.

Wheat is grown to a very limited extent and is confined chiefly to Shawano, Oconto, and Marinette Counties. In 1909 these three counties had a total acreage in wheat of about 7,000 acres, which gave an average yield of about 15 bushels per acre.

Potatoes are an important cash crop and one upon which many of the new settlers largely depend. The crop is grown on practically all of the soil types mapped. In the southern portion of the area where dairying is well developed, potatoes are grown more often on the lighter soils than on the heavy types, but in the northern and newer agricultural sections potatoes are grown on all types of soil. Yields of 200 and 250 bushels per acre are not uncommon for fields of 10 or 12 acres in extent.

Peas are grown both for seed and for canning purposes. In 1909 there were nearly 11,000 acres of peas grown to maturity in addition to a large acreage for canning purposes. Canning factories are located at Oconto, Oconto Falls, and Antigo.

Buckwheat is grown to a limited extent, but is confined chiefly to the light textured soils. Yields usually average from 15 to 18 bushels per acre.

While beans can be grown successfully and profitably on many of the soils within the region, the acreage devoted to this crop is limited. They are confined chiefly to the sandy types of soils.

The following table shows the total acreage and yields of the various general farm crops which are grown in each of the six counties included in this soil survey report.

Table Showing Approximate Acreage and Yields of Crops most Extensively Grown in Each of the Counties Surveyed. From U. S. Census, 1910.

	Florence	Forest	Langlade	Marinette	Oconto	Shawano
Approximate area in sq. mi.-----	498	1045	855	1413	1080	1135
Per cent of land under cultivation.....	2.6	.65	8.5	8.6	18.8	23.0
Hay & Forage						
Acres.....	3468	2239	18891	23690	42034	41478
Yield, tons....	3089	2830	27807	31899	60019	63206
Corn						
Acres.....	64	55	602	3597	7441	12575
Yield, bushels	1824	968	24367	94913	23913	500719
Oats						
Acres.....	1612	617	9554	13029	24975	35010
Yield, bushels	45053	22010	325550	405503	752296	1049130
Barley						
Acres.....	195	66	2597	1499	4016	9139
Yield, bushels	4241	1702	70481	32019	83543	227886
Potatoes						
Acres.....	379	483	1329	3689	3099	4061
Yield, bushels	57898	62998	180970	439857	30400	506125
Wheat						
Acres.....	54	10	193	893	2028	4171
Yield, bushels	872	182	3382	15669	30907	73554
Rye						
Acres.....	51	15	630	2487	4566	6667
Yield, bushels	980	242	12699	43989	68274	99927
Peas (Dry)						
Acres.....	20	23	1549	48	5640	3452
Yield, bushels	369	340	27331	698	82231	48711

Special Crops.—There are a few special crops grown within the area, though intensive agriculture has not become highly developed. Sugar beets are grown successfully, though on a small scale. Ginseng is quite extensively grown in Langlade County.

In the vicinity of the larger towns there are small tracts devoted to the raising of special crops. Strawberries are probably grown more extensively than any of the other trucking crops, and very satisfactory results are obtained.

Cucumbers are grown in several localities, especially on the sandy soils. A number of salting stations are located within the area. Cabbage, lettuce, tomatoes, celery, and a number of other garden crops are grown in a limited way, chiefly for home use.

Fruit.—The apple is the most important fruit. Most of the orchards are confined to the southern portion of the area, and have been planted chiefly on the rolling Superior and Miami fine sandy loams. Throughout the region covered by these types nearly every farmer has a small apple orchard. Among the varieties most extensively grown are Wealthy, Duchess, Northwestern Greening, Red Astrakhan, Grimes Golden, Wolf River, Northern Spy, Early Harvester, Snow, and a number of varieties of crabs. Cherries, plums, pears, and grapes are grown to a very limited extent, but sufficient has been done with these fruits to indicate that they can at least be grown for home use.

Dairying.—Dairying is the most important branch of agriculture followed at the present time within the area, and the one which gives the greatest promise of extensive growth as the country develops. Pure bred sires are being used in building up the herds. In 1910 the value of the dairy products from this area amounted to \$1,624,000, and at present the output doubtless amounts to over \$2,000,000 annually. The greater proportion of the dairy output is sold in the form of cheese and butter. In 1913 there were 41 creameries and 116 cheese factories within the area.

Table Showing Importance of Dairy Industry in Each County in the Area Surveyed.
From U. S. Census, 1910, and Wisconsin Dairy and Food Report, 1910.

	Florence	Forest	Langlade	Marinette	Oconto	Shawano
No. Dairy Cows.....	709	565	7215	8335	15709	24093
Milk produced— Gallons.....	189069	146716	1339382	1806906	4016478	8728344
1910.....	0	0	6	2	12	18
Creameries 1913.....	0	1	7	5	12	16
1910.....	0	0	9	7	23	62
Cheese Factories 1913.....	0	0	10	5	33	68
Value of Dairy Products, excluding Home Use of Milk and Cream.....	\$20,480	\$19,331	\$199,361	\$235,987	\$410,650	\$738,188

The raising of beef cattle has not reached any extensive proportions in this portion of Wisconsin. Some of the lumbering interests, and also private individuals, owning large tracts of cut-over land buy up young cattle in the spring, allow them to graze until fall, and then sell them again either as feeders or frequently as grass finished cattle. Excellent pasture is afforded all through the cut-over regions on the heavier types of soil, and in addition to the profits derived from the increased weights of the cattle, this grazing also assists in the clearing of the land, which is a very important item.

In the older portions of the survey hogs are raised chiefly in conjunction with dairying. Sheep are raised, though not as extensively as hogs.

Relation of Soils and Crops.—The question of the adaptation of soils to crops has not been given as much consideration in this region as in many sections of the country which have been under cultivation for a longer time. There are a number of specific instances, however, which indicate an appreciation of the fact that certain crops and certain types of farming are better adapted to one type of soil than to another. It is generally recognized that rye will do better on sandy soils than will any of the other small grain crops. Greater success is obtained on the fine sandy loam and silt loam soils with the dairy industry than on the light sandy soils. Potato growing can be made more successful on lighter soils than can the growing of a number of other crops. Beans and buckwheat are crops which also give very fair results on the sandy types of soil.

Crop Rotations.—Various crop rotations are practiced within the area, but little careful study has been given to the selection of rotations which are best adapted to the varying conditions of the soil. In the southern part of the area on the silt loam and fine sandy loam soils, where considerable corn is raised, a rotation quite commonly followed consists of corn for one year, followed by oats or barley seeded to timothy and clover. Hay may be cut for one or two years, and the field then pastured for one or two years, after which it is again plowed for corn. On the sandy soils a rotation which is quite common consists of rye for one year followed by clover and then by potatoes, corn, or beans. Buckwheat may then be grown for one year.

It is desirable that fall plowing should be practiced on the heavier types of the area whenever this is possible. On the steepest slopes, where there is some danger of erosion, it would be advisable to plow in the spring. The light sandy soils may be plowed in the spring, since the moisture conditions will permit working such soils very early.

Barnyard manure is the only fertilizer extensively used in the area. Green manuring is not practiced to any extent, though there are a few farmers who frequently plow under a crop of clover or rye.

Weeds.—The most important weed pests within the survey are Canada thistle and quack grass. Wild mustard is also found growing extensively in a number of places. Immediate steps should be taken to eradicate such pests.

Land Clearing.—In developing new farms in this region the clearing of the land is the first operation with which the settler has to concern himself. In some parts of the area stones are plentiful, but the most stony portions of the farms are left for pasture. In clearing the usual method is to select a site which seems best suited for the location of the farm buildings, and start clearing from this point. All brush, logs, and stumps may be removed from a rather small tract so that cultivated crops can be readily grown, and then a larger area cleared of the brush and logs. The tract not stumped may be seeded and pastured, and the stumps gradually removed, or cultivated crops may be grown between the stumps. After a few years the hardwood stumps will decay and can be easily pulled or burned out. Stump pulling machines, dynamite, and fire are all used in clearing the land of stumps. In many places fires have run through the cut-over country and cleared away most of the underbrush and old logs, so that the cost of preparing the land for the plow is greatly reduced.

The following table shows the area of the different counties, the number and size of farms, and the percentage of improved land in each of the counties, together with the average value of farm property.

Table Showing Amount of Improved Land, Size of Farms, Increase in Value of Farm Property, etc. From U. S. Census, 1910.

	Florence	Forest	Langlade	Marinette	Oconto	Shawano
Approximate land area—acres.....	318080	896000	560000	905600	715520	741120
Per cent of land area in farms.....	9.2	3.1	23.0	24.0	39.8	51.4
Number of all farms	2741	237	1434	1919	2868	3549
Average size of farms—acres.....	106	119	90	114	99	107
Per cent of farm land improved.....	29.1	21.7	37.1	36.2	47.0	44.7
Average improved land per farm—acres.....	31	26	33	41	47	48
Improved land in farms 1910—acres	8491	6129	47788	79474	133961	170318
Improved land in farms 1900—acres	4312	1573	\$31168	47126	91273	135322
Average value per acre of farm property 1910.....	\$16.00	\$21.08	\$31.69	\$23.67	\$31.40	\$35.05
Average value per acre of farm property 1900.....	\$8.45	\$10.72	\$13.55	\$13.33	\$16.55	\$17.27
Per cent of farms operated by owners..	93.4	92.8	92.0	93.9	94.6	95.4

Land Values.—The value of land is variable, depending upon the character of the soils, the topography, location, amount of improvements, and the amount of timber. Some of the lightest sandy soils can be bought for as low as \$4.00 per acre. The best grade of cut-over land frequently sells as high as \$20 to \$25 per acre, and most of the wild land without timber will have a value between these limits. Good hardwood timber land has a selling value of from \$20 to \$50 per acre, depending upon its location, the condition of the timber, and the ease with which it can be gotten out. In the regions where farming is well developed, land values are quite high—often \$75 per acre and in some cases \$100 or more per acre.

While the agriculture of the southern part of the area is well developed and the farmers, as a class, are in a prosperous condition, there are a number of ways by which the methods of farming might be improved and the returns from the farms increased. Suggestions along this line are given under the specific groups of soil to which they refer.

CHAPTER VIII

CLIMATE*

Among the factors which influence the agriculture of a state, none is more important than climate. The class of crops which can be grown is largely determined by the length of the growing season, and the amount and distribution of the rainfall. Any one of these factors may determine the type of agriculture which can be practiced to best advantage.

The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation having a range of from 28 to 34 inches, while the mean for the State as a whole is 31 inches.

The local distribution of rainfall varies, however, from year to year in different sections. The variation is caused by the movement of cyclonic storms. The average rainfall for the entire State during the driest year was 21.4 inches, and for the wettest year 37 inches.

The distribution of the rainfall during the year is just as important as its total amount. In this respect Wisconsin is unusually fortunate, since about half of the total rainfall comes in May, June, July, and August, and nearly 70 per cent from April to September, inclusive. The average rainfall for the State during the winter is 3.9 inches, during spring 8.3 inches, during summer 11.4 inches, and during autumn 7.4 inches. The small winter precipitation in Wisconsin, mostly in the form of snow, causes virtually no leaching of fertility from the soil or erosion.

The following table gives the mean precipitation at five points in the area and also at Menominee, Michigan, which is just across the Menominee River from Marinette, Wisconsin.

*For further information see Wisconsin Expt. Sta. Bul. 223.

Mean Precipitation at Menominee (Michigan), Florence (Wisconsin), Crandon, Oconto, Shawano, and Koepenick

	Florence	Crandon	Menominee	Oconto	Shawano	Koepenick
Length of record	19 years	19 years	19 years	19 years	19 years	19 years
December.....	1.54	1.12	0.52	1.80	1.52	1.26
January.....	1.16	1.46	0.76	1.64	1.32	1.35
February.....	1.10	1.08	1.05	1.56	1.15	1.28
Winter.....	3.80	3.66	2.33	5.00	3.99	3.89
March.....	2.00	1.48	1.48	2.15	1.69	1.86
April.....	2.44	1.48	1.73	2.95	2.77	2.71
May.....	3.98	2.38	3.39	3.60	2.97	3.62
Spring.....	8.42	5.34	6.60	8.70	7.43	8.19
June.....	4.15	2.62	3.63	3.40	3.16	3.96
July.....	3.86	3.15	4.36	3.32	3.46	3.84
August.....	3.35	2.70	2.68	2.50	2.26	3.41
Summer.....	11.36	8.47	10.67	9.22	8.88	11.21
September.....	3.61	3.76	3.27	3.00	2.88	4.21
October.....	2.86	2.65	1.63	2.24	2.41	3.17
November.....	2.05	2.26	1.18	2.07	1.61	1.98
Fall.....	8.52	8.67	6.08	7.31	6.90	9.36
Annual.....	32.10	26.14	25.68	30.23	27.20	32.65

It will be seen from the above table that the mean annual precipitation of the area surveyed is 29 inches. The precipitation seems to be more effective in this region than the same rainfall would be a few hundred miles south. One reason for this is that the season is shorter, average temperatures are somewhat lower, and there is less moisture lost by evaporation.

A large proportion of the area surveyed lies within "The Northern Highland," which is recognized as one of the eight climatic provinces of Wisconsin. The portion of this region within the area has an elevation ranging from a few feet above the level of Lake Michigan to over 1000 feet above the level of the Great Lakes. It includes the head waters of the Wolf and Eau Claire Rivers, smaller tributaries of the Wisconsin River, and the courses of the Peshtigo, Oconto, Pine, and a number of other good sized streams. The northern portion of the area is characterized by a short growing season, cold winters, warm summer days, and cool summer nights. In the extreme north the growing season for corn and potatoes is about 100 days, but this gradually lengthens with the distance south and east, until in

the southern and southeastern portions of the area bordering Green Bay, there is an average growing season of about 150 days. As far inland as Shawano there is a growing season of over 130 days.

The following table gives the average dates of the last killing frost in the spring and the first in the fall, at various stations within the area and at Menomonee, Michigan.

Table Showing Frost Dates for North Eastern Wisconsin

Station	Length of record	Average date of		Elevation of station above sea level
		Last killing frost in spring	First killing frost in fall	
	Years			Feet
Florence.....	18	June 2	Sept. 13	1293
Crandon.....	12	June 3	Sept. 14	1060
Menomonee.....	9	May 14	Oct. 6	
Michigan				
Oconto.....	19	May 10	Oct. 2	590
Shawano.....	13	May 14	Sept. 26	796
Koepenick.....	18	June 3	Sept. 17	1683

From this table it will be observed that the average date for the first killing frost in the fall at the different stations ranges from September 13 to October 6, and the average date for the last killing frost in the spring at the different stations ranges from May 10 to June 3. In the extreme northwestern part of the area summer frosts may occur, but these are seldom of sufficient severity to seriously injure growing crops. As the timber is cleared away, the land more thoroughly drained, and more of the land put under cultivation, the growing season will gradually lengthen.

While the growing season for corn, potatoes, and other crops affected by light frosts is relatively short in the extreme northern portion of this area, the growing season for the small grains, grass and root crops is more nearly equal to that in the southern part of the State. The spring is a little later, but grass and hardy vegetables grow nearly if not quite as late in the fall as they do in the southern part of the State. Fig. 2 shows the length of the growing season between frosts which would kill corn. Fig. 3 shows the average temperature for the six growing months, and forms a more accurate basis for comparing periods of growth throughout the State than Fig. 2 since many crops withstand considerable frost.

The climatic influence of Green Bay is confined to a belt of from 5 to 10 miles in width, immediately bordering the bay. The southeastern half of the area has a growing season which is practically the same as that in the southwestern portion of Wisconsin, including St. Croix, Pierce, Buffalo, Monroe, Richland, Iowa, and intervening

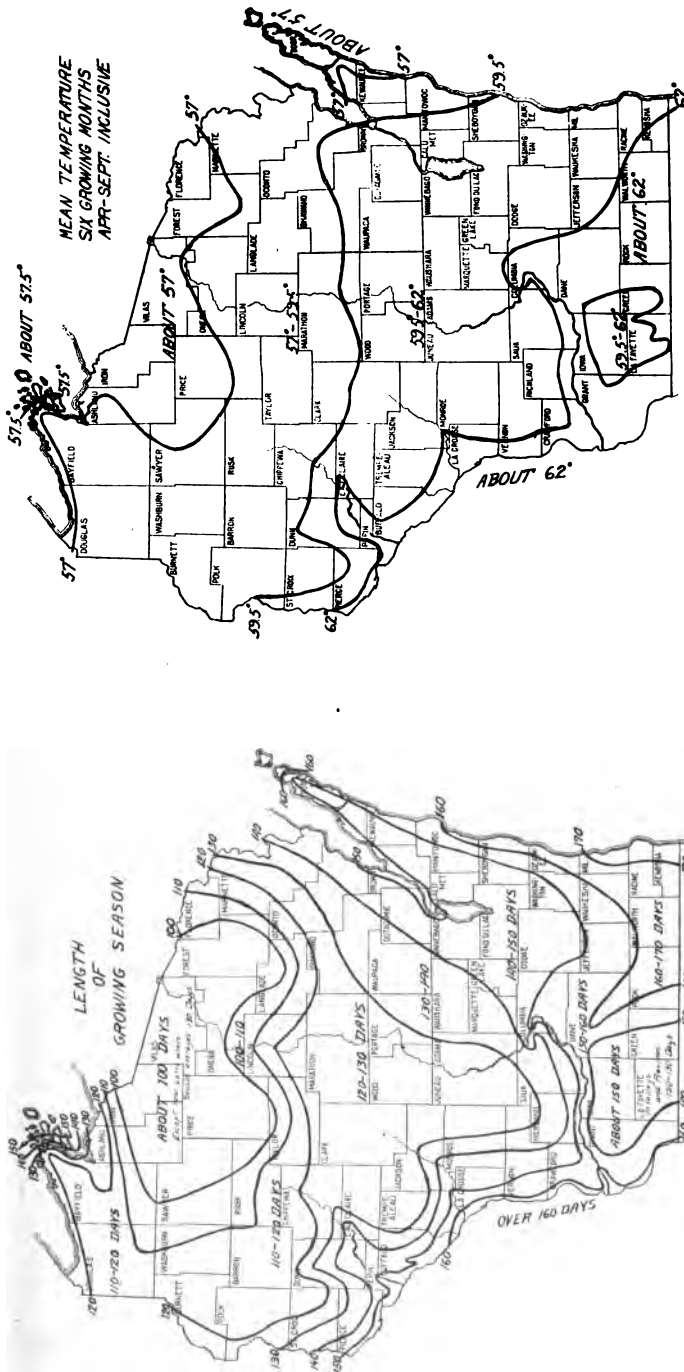


Fig. 3. Map showing average temperature for the six growing months April to September, inclusive. Note that the difference between the average temperature for the areas surveyed, and the southern portion of the State is only slight, varying from 2.5 to 5 degrees.

Fig. 2. Map showing length of growing season for corn.

counties. The portion of the area immediately bordering Green Bay has about the same length of growing season as Fond du Lac, Winnebago, Dodge, and Calumet Counties.

The mean summer temperature ranges from 63.6° to 66.9° and the mean annual temperature for all the stations is 41.5°. There are about five days during the summer when the temperature rises above 90°, and it seldom gets as high as 100°, and there are also about five days during the winter when it falls lower than 20° below zero.

While the winters are long and severe, the summers are delightful, and all crops make a wonderfully rapid growth when spring opens. The delightful summer climate of this region, the excellent fishing in streams and lakes, the good water which can be readily secured in all parts of the area, the summer resorts on the lakes, and the hunting attract a considerable number of people to this region each year. These factors, together with the large areas of excellent unimproved agricultural land, are also instrumental in attracting large numbers of new settlers to this region.

SUMMARY

The area covered by the reconnaissance soil survey of northeastern Wisconsin includes six counties, Forest, Florence, Marinette, Oconto, Shawano, and Langlade, and embraces a total area of 6,098 square miles, or 3,902,720 acres, located in the extreme northeastern portion of the State. The surface features are characteristic of a glaciated region, and the topography varies from level to rough and broken. Elevations range from practically the Great Lakes level to over 1,000 feet above. The highest portion is the Northern Highlands, where many important rivers of the State rise. Some of these through their rapid descent within the area afford much potential water power. The earliest settlement of the area dates back to 1786, but industrial activities did not begin until about 1832, when the first lumber mill was started in Marinette. Lumbering was the most important industry for almost 50 years. Agricultural operations were not well under way until the seventies and farming could not be considered of much importance before the eighties, when the southeastern portion of the region surveyed was rapidly being settled and put under cultivation. Throughout the northern part of the area lumbering is still the most important industry, but agriculture is rapidly developing wherever the timber has been removed.

Three important railway systems traverse this region, providing excellent transportation facilities and connecting this section with some of the largest and most important markets of the Middle West.

The region covered by the present survey, in common with all of northern and eastern Wisconsin, owes the general character of its surface to glacial action. The glacial drift which covers this region has been derived largely from the underlying geologic formations, of which there are six, and all of these have contributed to a greater or less extent in the formation of the various soils. Ten soil series and 25 soil types, excluding Peat, Muck, and Rock outcrop, have been recognized and mapped in this survey. The material composing these soils has all been derived from glacial till, though some of it has been reworked and deposited by water and modified by the action of the wind or by the incorporation of organic matter since its first deposition.

The Miami series includes the light colored upland timbered soils in the glaciated limestone region, and two types were mapped. The

fine sandy loam and loam include some of the most highly improved farming land in the area.

The Fox series includes light colored timbered soils of alluvial origin which have been formed in the glaciated limestone region as glacial outwash plains, filled-in valleys, or stream terraces. Only the fine sandy loam type was mapped in this survey. It is inextensive, but usually found under cultivation.

The Coloma series includes light colored timbered noncalcareous upland soils in the glaciated region derived largely from Potsdam sandstone material. The soils are coarse in texture, and the three types recognized in this survey are not extensively utilized as yet, but are all capable of development. The amount of organic matter is small.

The Kennan series consists of light colored noncalcareous upland timbered glaciated soils where the material has been derived largely from crystalline rocks. The silt loam and fine sandy loam are the only types mapped as belonging to this series, but both of these cover extensive areas.

The Vilas series is similar to the Kennan, but is derived only in part from glacial crystalline rock material and in part from glaciated sandstone debris. No soils heavier than a sandy loam are included in this series. The types mapped are Vilas sandy loam, sand, stony sand, and fine sand.

The soils of the Antigo series consist of material derived from crystalline-rock formations, which were deposited late in the glacial period as terraces. Two types were recognized—the silt loam and fine sandy loam. The silt loam is one of the best soils in northern Wisconsin and mostly under cultivation. The fine sandy loam is not as yet utilized for farming.

The Plainfield series consists of light colored timbered noncalcareous soils of alluvial origin which have been formed as glacial outwash plains or stream terraces. The fine sand, sand, and sandy loam are mapped in this area. The soils are low in organic matter.

The Superior soils in this Survey consist chiefly of lacustrine material possibly modified by glacial action. The original heavy material having been overlain in places by light-textured deposits. The typical soils have a level surface and drainage is not thorough. The types mapped are Superior fine sandy loam and fine sand, and rolling phases of fine sandy loam, loam and clay loam.

The Colby series includes light colored timbered upland soils from the older drift material, derived largely from crystalline rocks. Only one type, the silt loam, was mapped.

The Poygan series is of lacustrine origin and resembles the Superior but the surface soil is dark colored. It is of limited extent, and only one type, of no great agricultural importance, the fine sandy loam, was mapped in this survey.

The Clyde soil mapped is the loam. This is high in organic matter, occupying old lake beds, drainage channels, and ponded valleys. It is partly alluvial and partly lacustrine in origin and is calcareous. It is inextensive and only a small proportion of it has been cleared and tilled.

Peat and Muck include areas of organic deposits in varying stages of decomposition. Much of the area covered by these soils can be drained and used to great advantage for farming. Peat and Muck cover one-sixth of the entire area surveyed.

Rock outcrop includes exposures of the underlying bedrock of such extent or so numerous as to preclude tillage. It covers large areas.

Within the region surveyed all stages of agricultural development are represented. The southeastern and southern portions are well settled and highly improved, with land values ranging from \$50 to \$100 an acre for the best improved farms, while the northern portion is largely in virgin forests of hardwoods. Cut-over land can be bought for \$4 an acre and upward, depending upon the character of the soil and the location. The lightest sandy soil, originally covered with pine, has a low agricultural value, but the cut-over hardwood regions include much excellent land which offers exceptional opportunities for agricultural development. The chief crops grown at present are oats, hay, corn, potatoes, barley, rye, wheat, peas, sugar beets, buckwheat, and a number of trucking crops, the last being grown only to a limited extent. As reported in the census of 1910, Shawano County has 51.4 per cent of its entire area in farms, of which 44.7 per cent is in improved land. In Forest County only 3.1 per cent of the land is in farms, and of this only 21.7 per cent is improved. The other counties range between these two extremes in the extent of improvement. During the decade 1900 to 1910 the average value of farm property practically doubled. The type of farming chiefly followed at present consists of general farming in conjunction with dairying. There are 43 creameries and 116 cheese factories within the area, and the dairy industry is being gradually extended.

The winters of this region are long and cold, but the summers are delightful, and all crops make rapid growth. Excellent water is available in all parts of the area, and the region is a healthful one.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE

H. L. RUSSELL, Dean.

BULLETIN NO. XLVIII

SOIL SERIES NO. 13

SOIL SURVEY
OF
JEFFERSON COUNTY
WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, AND O. J. NOER

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

AND

A. H. MEYER

OF THE

UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES
DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS,
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

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MAP

Soil Map of Jefferson County, Wisconsin.....	<i>Attached to back cover</i>
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INTRODUCTION

Before the greatest success in agriculture can be reached, it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin, working in coöperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made, to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the State, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors: first, upon the physical characteristics of the soil, such as water holding capacity, workability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity, and other physical properties of soil all depend chiefly upon *texture*, which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere. Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis*, which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION.

Soils are grouped according to texture into soil classes, a soil class being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

SOILS CONTAINING LESS THAN 20% SILT AND CLAY

- Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.
Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very fine sand.—Over 50% very fine sand.

SOILS CONTAINING BETWEEN 20-50% OF SILT AND CLAY

- Sandy loam.—Over 25% fine gravel, coarse and medium sand.
Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Sandy clay.—Less than 20% silt.

SOILS CONTAINING OVER 50% OF SILT AND CLAY

- Loam.—Less than 20% clay, and less than 50% silt.
Silt loam.—Less than 20% clay, and over 50% silt.
Clay loam.—Between 20 and 30% clay, and less than 50% silt.
Silty clay loam.—Between 20 and 30% clay, and over 50% silt.
Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the different soils constitute merely a graduation in texture of otherwise uniform material, such a group is called *soil series*. It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for examples, includes light colored,

glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, where the parent rock was largely sandstone, and where the material occurs as outwash plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey.

By uniting the name of the *soil class* which refers to texture, with the name of the *soil series* which refers chiefly to origin, we get the *soil type* which is the basis or unit of classifying and mapping soils. A *soil type* thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

It is fitting that in this report on the Soil Survey of Jefferson County recognition should be made of the distinguished services rendered to agriculture by Ex-Governor William D. Hoard whose home is in the county. This recognition has a peculiar fitness because of the important part which he, then a regent of The University of Wisconsin, gave toward the establishment of the Wisconsin Soil Survey by the legislature of 1909.

SOIL SURVEY OF JEFFERSON COUNTY, WISCONSIN

CHAPTER I.

GENERAL DESCRIPTION OF THE AREA.

Jefferson County is located in the southeastern part of Wisconsin. It is bounded on the north by Dodge County, on the east by Waukesha County, on the south by Walworth and Rock Counties, and on

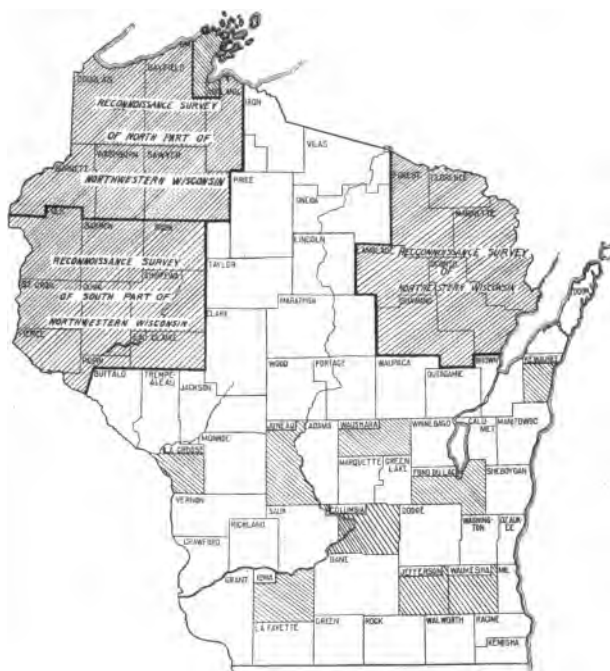


Fig. 1—Sketch map showing area surveyed

the west by Dane County. The eastern limit of the survey is 33 miles from Lake Michigan and the southern boundary is 24 miles from the Illinois State line. The county, which has the form of a square, each side measuring 25 miles, is composed of 16 townships

and comprises an area of approximately 570 square miles, or 364,800 acres.

The surface features of Jefferson County are characteristic of a glaciated region and the topography varies from level to rolling and hilly. A conspicuous result of the glaciation is the large number of rounded hills or drumlins that occur throughout the region north of Bark River and east of Rock River, where they form a series of parallel ridges running in a north and south direction. In a large number of instances throughout this region the intervening low areas consist of Peat marshes. In the eastern part of Oakland Township and in the southern part of Koshkonong Township the hills are higher than elsewhere, though the intervening areas are less broken. In general the hills or drumlins lying south of Bark River and west of Rock River are higher, with more irregular outlines than those in the eastern and northeastern parts of the county, and the intervening land usually consists of upland instead of Peat marsh. The average elevation of the county is between 800 and 900 feet above sea level.

Another pronounced topographic feature is the Kettle Moraine, which crosses the extreme southeastern corner of the county, running in a northeast and southwest direction. It covers about 6 square miles and includes the roughest portion of the survey. It attains an elevation of 1,040 feet, which is 265 feet above the level of Lake Koshkonong, the lowest body of water in the survey. Another, though less pronounced, moraine belt enters the county in the northwestern part of Sumner Township and extends to the northeast through Oakland and Lake Mills, terminating in the southeastern part of Waterloo Township. There are a number of small, flat areas associated with this belt.

To the northeast of Fort Atkinson there is a level to undulating tract several square miles in extent and a similar area occurs north of Jefferson on the west side of Rock River. Other small areas of like character occur in the northeastern part of Ixonia and Concord Townships.

There are a large number of low, wet areas, mostly Peat marshes, in the county, the most extensive of which lie in Palmyra, Cold Spring, Hebron, Jefferson, Sullivan, and Concord Townships. Other smaller areas of Peat are found scattered throughout the survey and associated with nearly all of the various soil types. Numerous areas of Clyde soils, level, low, and naturally poorly drained, occur in all parts of the county, though most extensively in Waterloo, Watertown, Koshkonong, and Cold Spring Townships.

The drainage of practically the entire county is through the Rock River and its tributaries into the Mississippi River. Rock River enters the northeastern corner of the county, flows south through Ixonia Township, thence northwest to Watertown, where it swings to the southwest, crossing the county and leaving it through Lake Koshkonong, in the extreme southwestern corner. Watertown, Jefferson, and Fort Atkinson are situated upon Rock River. Bark and Oconomowoc Rivers and several smaller streams enter the Rock River from the east, and Crawfish River and several creeks from the west. Two dams which furnish power for factories cross Rock River, one at Watertown and one at Jefferson. A number of dams have also been built along some of the smaller streams to provide power, chiefly for running grist mills.

The first permanent settlements in Jefferson County were made at Hebron, Watertown, and Aztlan during the year 1836, the pioneers coming largely from New York, Vermont, and Massachusetts. In 1842 a number of Germans, Norwegians, English, Scotch, and a few Irish immigrated to this region. The Germans located chiefly in Watertown, Ixonia, Farmington, Concord, Oakland, and Jefferson Townships; the Norwegians in western Oakland, Sumner, and Lake Mills Townships; the Scotch in Lake Mills, and the English in Palmyra and Cold Spring Townships. The population, which at present is composed mainly of persons of German descent, is well distributed, and all portions of the county are settled and improved agriculturally.

Watertown, situated on the Rock River, in the north-central part, is the largest city of the county, having a population of 8,829. It is in the midst of a good agricultural section, has a number of factories, and is a market and shipping point of importance. Fort Atkinson, with a population of 3,877, is located in the southwestern part of the county on the Rock River and is surrounded by well-improved farming country. It is quite a manufacturing community, contains two nurseries, is headquarters for important breeding associations and the home of one of the leading agricultural and dairy papers of the West. Jefferson, the county seat, with a population of 2,582, is near the center of the county on the Rock River. It is also a manufacturing and shipping point of importance. Waterloo, with a population of 1,220, is situated in the northwestern corner of the county. Lake Mills, with a population of 1,672, is also located in the northwestern part on Rock Lake, and is somewhat of a summer resort. Many pure-bred cattle raised in the surrounding country are sold in this town each year. Johnson Creek, Palmyra,

Hebron, Rome, Hubbleton, Sullivan, and Helenville are smaller towns and villages.

Jefferson County is well supplied with railroads. It is crossed by the main line of the Chicago, Milwaukee & St. Paul Railroad, and several branches of this road, and by two branches of the Chicago & North Western Railroad. The Milwaukee Electric Light & Railway Co. has an electric line running from Watertown to Milwaukee which crosses the northeastern corner of the county and is parallel with the main line of the Chicago, Milwaukee & St. Paul Railroad. These lines provide excellent transportation and shipping facilities and no point in the county is over 7 miles from a railroad.

The cities and towns within the county afford a market for a considerable part of the farm produce, though large quantities of milk, butter, cheese, poultry, live stock, and other products are shipped to outside markets. Of these, Chicago and Milwaukee are by far the most important. From Watertown to Milwaukee over the Chicago, Milwaukee & St. Paul Railroad it is 45 miles and to Chicago 130 miles.

In general the public roads of the county are kept in good repair. Macadamized roads lead out from Lake Mills and Fort Atkinson. There are excellent roads in the vicinity of Palmyra, where gravel is easily obtainable. In most sections the roads are graded and wherever gravel is available it is used in crowning them. There are sections of the survey, however, where good gravel can not be obtained without hauling long distances, and in these places the roads are frequently in rather poor condition. The mileage of improved highways is increasing each year; there are no toll roads in the county. All communities are reached by the Rural Free Delivery Service and the telephone is in common use among the farmers.

SOILS

Jefferson County lies entirely within the glaciated region and owes the general character of its surface to glacial action. The soil material forming the surface of the region was deposited by two ice lobes, both of which were a part of the Late Wisconsin ice sheet. Along the line of contact between these two ice sheets was formed the Kettle Moraine, or Medial Moraine, as it is sometimes called. This consists of a very conspicuous range of hills extending from near Delavan, in Walworth County, to the central part of Kewaunee County. Where it crosses Palmyra Township it is the most noticeable feature of the landscape. Outside of the Kettle Moraine the

material deposited by the ice sheet is known chiefly as ground moraine, though there are numerous recessional moraines in various parts of the county, and in these sections the surface is quite rough. The surface of the ground moraine varies from level to gently rolling and rolling. It is frequently in the form of elongated ridges or drumlins which are interspersed with numerous areas of low-lying, poorly drained land. The southern portion of the survey is traversed by an old preglacial valley extending from near Oak Hill to Fort Atkinson, and at present this is occupied by low, poorly drained soils and Peat marshes. Numerous old lake beds occur throughout the county, and many of these have become filled by the growth and decay of rank vegetation and by the accumulation of mineral matter washed in from the higher lands adjoining. Many of the level tracts in the upland consist of outwash plains, this material being deposited by streams flowing from beneath the glacial ice.

The glacial till which covers this entire region consists of a mixture of clay, silt, sand, gravel, and boulders and extends to a depth varying from a few feet to several hundred feet. Throughout the central and eastern portions of the county it rests upon the Trenton limestone and along the western boundary the surface rock is the St. Peters sandstone. In the extreme northwest part of the county there is an outcrop of Baraboo quartzite, but this is of limited extent. There is also a very small area where the Lower Magnesian limestone is the first rock encountered. All of these rock formations have been ground down by the action of the ice, and the material now forms a part of the fine earth, gravel, and rock fragments which go to make up the mantle of soil.

Since its first deposition the glacial material has been influenced by the action of water, wind, and weathering, by the growth and decay of vegetation, and by other agencies, and has thus been modified to a considerable degree. Varying degrees of modification by different agencies have given rise to different soils. These soils are grouped into series mainly on the basis of color, structural characteristics, and origin, and into types on the basis of texture. In the present soil survey this soil material was classified into 7 soil series and 24 types*, with a number of phases. Many of these are of small extent, but nevertheless distinct.

The Miami series is the most extensive and consists of the light-

*The Clyde clay loam as described in this report includes what was mapped and described in the Bureau of Soils' edition of the Jefferson County report as Clyde silty clay loam.

The Fox silt loam, deep phase, covered by this report includes what was previously described as Fox silt loam, heavy phase, and the Fox fine sandy loam includes what was previously described as Fox fine sandy loam, deep phase, while the Fox loam includes what was previously described as Fox loam, deep phase.

The Plainfield fine sand as described in this report includes what was previously described as Fox fine sand, and the Plainfield sand includes what was previously classed as Fox sand.

colored, forested, upland soils derived from unassorted glacial till in which there is a quantity of limestone material. This series is of great importance in southeastern Wisconsin, Michigan, Ohio, Indiana, Illinois, and Minnesota. The types in this series mapped in Jefferson County are the silt loam, loam, fine sandy loam, gravelly sandy loam, and fine sand.

The Fox series is of smaller extent and of less importance. It includes the light-colored material occupying outwash plains and terraces along old filled-in valleys in the glaciated limestone region. The types recognized are the silt loam, loam, and fine sandy loam.

The Rodman series includes light-colored assorted glacial material chiefly in the form of kames and eskers. The soils are very droughty and have a low agricultural value. They differ from the Miami soils chiefly in being underlain by loose, open, stratified material instead of till. The types recognized and mapped in the present survey are the gravelly sandy loam, fine sandy loam, fine sand, and gravel.

The Plainfield series includes light-colored glacial material occupying outwash plains and river terraces where there is no limestone material present, or only such a small amount as to have no appreciable influence on the agricultural value of the soil. Two types belonging to this series were recognized in Jefferson County, the Plainfield sand and fine sand.

The Carrington series includes the dark-colored prairie soils in the glaciated region. The series is extensively developed in southeastern Wisconsin, in Fond du Lac, Dodge, Dane, Columbia, Walworth, and Rock Counties, and in the adjoining States of Minnesota, Iowa, and Illinois. It is a very good general farming series. In this survey, however, it occupies only a very small area. The types mapped out are the silt loam, loam, and fine sandy loam.

The Waukesha series includes dark-colored outwash material, one type, the Waukesha loam, being mapped. It is inextensive.

The Clyde series occupies old lake beds in the glaciated region and is characterized by its dark color and high organic-matter content. The subsoil is usually calcareous and the surface seldom acid. The types mapped in Jefferson County are the clay loam, silt loam, loam, sandy loam, and fine sandy loam.

The material mapped as Peat (with included areas of Muck) includes the accumulation of vegetable matter in varying stages of decomposition, and occupies old lake beds, marshes, ponded valleys, and the valleys of present-day streams. It is very extensive in this survey, but little of it has been improved.

The following table gives the names and extent of the several types mapped:

AREAS OF DIFFERENT SOILS.

Soil	Acres		Per cent.
Miami silt loam.....	69,760		} 21.2
Deep phase.....	7,616		
Peat.....	69,248		19.0
Clyde silt loam.....	64,128		17.6
Miami loam.....	45,824		12.6
Miami fine sandy loam.....	30,400		8.3
Miami gravelly sandy loam.....	15,424		4.2
Clyde loam.....	14,592		4.0
Clyde clay loam.....	12,864		3.5
Fox silt loam.....	5,248		} 2.3
Deep phase.....	3,712		
Fox fine sandy loam.....	5,376		1.5
Rodman gravel.....	4,160		1.1
Fox loam.....	4,096		1.1
Miami fine sand.....	3,712		1.0
Rodman gravelly sandy loam.....	2,816		.8
Rodman fine sand.....	1,792		.5
Plainfield fine sand.....	1,024		.3
Clyde sandy loam.....	896		.2
Plainfield sand.....	768		.2
Carrington loam.....	448		.1
Carrington fine sandy loam.....	320		.1
Carrington silt loam.....	256		.1
Waukesha loam.....	192		.1
Rodman fine sandy loam.....	64		.1
Clyde fine sandy loam.....	64		.1
Total.....	364,800		

CHAPTER II.

GROUP OF HEAVY, LIGHT COLORED SOILS.

MIAMI SILT LOAM

Extent and distribution.—The Miami silt loam is the most extensive of the upland types and with the Fox silt loam includes the finest agricultural lands of the survey. It occurs chiefly in the western, northwestern, and northeastern parts of the county. The areas are very irregular and broken by areas of other types, mainly Peat, and the Clyde silt loam. In Oakland Township the silt loam is mingled with areas of Miami gravelly sandy loam.

Description.—The surface soil of the Miami silt loam consists of a brownish-gray silt loam extending to a depth of 8 or 12 inches, with an average depth of 10 inches. The soil has a very smooth and velvety feel as a result of the high silt content. The subsoil consists of a brownish-yellow or buff heavy silt loam which becomes heavier with depth and grades into a silty clay loam. At an average depth of 24 inches a yellowish-brown gritty clay loam is encountered which extends to a depth of 4 or 5 feet, where a light-buff till is found. The layer of extremely silty material included in soil and subsoil varies in depth from 20 to 30 inches, this difference being due to erosion, which has removed some of the material from the hills and upper slopes and deposited it on the lower slopes. There are usually a few limestone pebbles and fragments in the subsoil but rarely any in the surface soil. In the second and third foot the subsoil is quite compact and holds the moisture well, though below this the structure is looser. When properly handled it is loose and friable, but may become more compact when cultivated under unfavorable moisture conditions. Originally there were quite a few boulders upon the surface in places, but these have practically all been removed from the cultivated fields.

Within the Miami silt loam type there are some variations worthy of note. The most important of these is the deep phase which has been indicated on the map and is described in detail following the description of the typical soil.

On many of the knolls and steeper slopes the heavy subsoil is exposed as a result of erosion, while in the smaller areas between

elevations and along lower slopes the surface soil is deeper than the average. In sections 1, 10, 12, and 13, Concord Township, sections 13 and 24, Ixonia Township, section 2, Milford Township, and section 9, Lake Mills Township, the type contains a considerable amount of fine sand in the surface and is lighter in texture than the typical soil. The subsoil is somewhat lighter and contains considerable limestone gravel. This phase approaches the Miami fine sandy loam, which it borders in places. In parts of section 17, Aztalan Township, and section 18, Sumner Township, the soil is darker than typical and approaches in character the Carrington silt loam. There are a few places in various parts of the county where the underlying rock comes close to the surface and frequently outcrops. Such tracts are usually too small to detract from the value of the soil for farming purposes, but in the southeast part of Waterloo Township there is a tract of about 10 acres, the value of which is greatly reduced by an extensive outcrop. Areas over which the soil is shallow are of very limited extent.

Topography and drainage.—The topography of the Miami silt loam varies from undulating to steeply rolling. The typical configuration, however, is gently rolling to rolling, and with the exception of a number of small tracts of a few acres each modern farm machinery can be used over all of the type. The uneven character of the type as a whole insures good surface drainage, though there are numerous depressions and draws in which tile drains could be installed to advantage. On some of the steeper slopes erosion is likely to prove damaging, and in order to protect such places it frequently becomes necessary to follow special methods of culture.

Origin.—The material composing the Miami silt loam consists chiefly of glacial débris laid down mostly in the form of ground moraine. The surface material, which is extremely silty and often stone-free, may have been deposited in part by the action of wind, as in places it has a loesslike appearance. The underlying material, however, is unassorted clay, sand, gravel, and boulders, a typical glacial till.

A very large proportion of the gravel consists of limestone, and limestone material has entered largely into the formation of the fine earth of this type. The subsoil does not show an acid reaction, and is often quite calcareous, but the surface has been leached to such an extent that a slight acid condition has developed in places. Sorrel is often found growing on the acid spots. Throughout most of the type sweet clover is found growing along the roads.

Native vegetation.—The original forest growth on the Miami silt loam in the northeastern part of the county and between the Rock

and Crawfish Rivers consisted chiefly of white oak, black oak, maple, basswood, ironwood, some elm, hickory, and butternut. This region was covered with a heavy growth of trees, but the type as found west of the Crawfish and Rock Rivers was sparsely forested. Most of it was known as openings and prairie grass grew between the trees.

There were two small prairies on the type; the Vanderpool Prairie, lying in sections 17, 18, 19, and 20, Waterloo Township, and another in section 16, Jefferson Township.

*Present agricultural development**.—Approximately 95 per cent of the Miami silt loam is under cultivation, and the greater part of this is highly improved. The remainder of the type is in scattered wood lots, of which most farms have from 5 to 10 acres.

The type of agriculture followed most extensively on this soil at the present time consists of general farming in conjunction with dairying. The raising of hogs is quite general, and from 20 to 25 are fattened each year on the average farm by feeding the by-products of the dairy along with corn.

Oats, corn, hay, and barley are the chief crops. Some rye and a little wheat are produced. The largest acreage is devoted to oats, which do very well on this soil, the average yield being about 45 bushels, with a maximum of about 65 bushels per acre. Corn yields from 35 to 80 bushels per acre, with an average of about 50 bushels. Barley is grown to some extent, but, owing to continued cropping on the same field, the yields have tended to decrease in recent years. The average yield is about 30 bushels per acre, but from 40 to 45 bushels per acre are sometimes obtained. Only a small proportion of the type is devoted to rye. The usual yield is from 20 to 25 bushels per acre. The acreage of wheat is very small, and there are a large number of farms on which no wheat has been grown for a number of years. Owing to the fact that the Miami silt loam has associated with it a large area of lowland suitable for pasture and marsh hay, the quantity of clover and timothy grown is smaller than would be expected. Clover does well, however, yielding on the average about 2 tons of hay per acre. When mixed with timothy the yield is somewhat lower. Alfalfa is an important crop on this soil, having passed the experimental stage. Three and sometimes four cuttings are made in a single season. Three tons per acre is about the average yield, though from 4 to 6 tons have been obtained.

Of the special crops, peas, tobacco, sweet corn, sugar beets, and potatoes are the most important. In the vicinity of Waterloo and north and northwest of Fort Atkinson about 1,000 acres of peas are

* For chemical composition and improvement of Miami silt loam, see page 28.

grown annually for the local canning factories. This type is well adapted to the crop, producing heavy yields of sweet-flavored peas. In the vicinity of Waterloo a few hundred acres of field peas are grown each year for seed, the average yield of which is about 20 bushels per acre.

In the southwestern part of the county, along the county line, some tobacco is grown. The yields range from 1,200 to 1,300 pounds per acre, and the net return in good seasons is from \$50 to \$75 an acre. From 5 to 15 acres represents the range in the size of the fields. The crop is grown only in this part of the county.

Sugar beets do very well on the type, but the acreage devoted to this crop is small. In the vicinity of Fort Atkinson sweet corn is grown for canning. The stalks and poor ears are either put into the silo or allowed to ripen and are fed to cattle in the form of stover. Potatoes are grown to a small extent by nearly all farmers for home use. Only in a few instances is any effort made to grow this crop on a commercial scale.

The value of a definite crop rotation is coming to be quite generally recognized. The most common rotation consists of one year corn, two years oats, or if there is no lowland on the place, one year barley and one year oats, two years clover and timothy, and one year pasture. When alfalfa is substituted for clover and timothy it occupies the land three or four years.

Stable manure is the chief fertilizer used. It is usually applied to sod land in preparation for corn. The summer accumulation is often spread upon the stubble fields. When alfalfa is grown a liberal application is given the field before seeding. Manure is usually applied at the rate of 10 to 15 tons per acre every three to five years. The supply is seldom sufficient to cover the whole farm at this rate and some fields receive but little, if any, manure. The plowing under of green crops to supplement the stable manure is practiced by some farmers, but the practice of green manuring has not been developed on this soil to any marked extent. Commercial fertilizers are not in common use. Some lime has been applied and rock phosphate has been used to a limited extent.

MIAMI SILT LOAM, DEEP PHASE

The surface soil of the Miami silt loam, deep phase, has the same color and structure as the typical soil, but averages slightly deeper and contains a somewhat higher percentage of silt, which gives it very smooth feel. The subsoil is a brownish-yellow or buff silt loam becoming heavier with depth. It contains slightly more silt than the

typical subsoil and grades into the silty clay loam at a slightly greater depth. The gritty clay loam is usually encountered at 30 to 36 inches, while in the typical soil it is found at an average depth of about 24 inches. The section in which the silt content is high may vary from 24 to 40 inches. The underlying typical till bed is usually found at about 6 feet.

The chief difference between this phase and the typical soil is that it has a slightly higher silt content and the stone-free section is somewhat deeper. This difference is not sufficient to justify classing it as a separate type.

Areas of the deep phase occur almost entirely in the western two rows of sections in Waterloo and Lake Mills Townships. The surface is undulating to gently rolling, as a whole less rolling than the typical soil, and the slopes are never steep enough to make erosion serious. The natural drainage is good. It has the same origin as the typical soil, but may have been influenced to a greater extent by wind action, thus accounting for the deeper silt layer. This phase was found in the forest "openings."

The methods of cultivation, crops grown, rotations followed, and crop adaptation are the same as for the typical soil, though the yields may be slightly greater.

MIAMI LOAM

Extent and distribution.—The Miami loam is the second upland soil in the county in importance, though there are several types which are more extensive. The type occurs chiefly east of Rock River, extending north from Hebron nearly to Watertown. There are no very extensive, unbroken tracts, as the type is interspersed with numerous low-lying areas of Peat and soils of the Clyde series.

Description.—The surface soil of the Miami loam consists of a grayish-brown loam of medium to fine texture, extending to an average depth of 10 inches. The type contains a considerable percentage of fine sand and silt and frequently grades into a silt loam so gradually that no sharp boundary can be drawn. The type has a friable structure, but as a whole is somewhat deficient in organic matter. Originally there was quite a scattering of boulders on the surface, but most of these have been removed from the cultivated fields. A little gravel is found on the surface in places.

The subsoil consists of a heavy brownish-yellow loam, which becomes heavier and more compact with depth, until at about 18 inches a gritty clay loam, frequently with a reddish cast, is encountered. This usually extends to a depth of 3 or 4 feet, where



VIEW OF MIAMI LOAM SOUTH OF WATERTOWN, SHOWING CHARACTERISTIC TOPOGRAPHY, BUILDINGS, AND
HIGHLY IMPROVED FIELDS.

This view is also typical of Miami silt loam. These two types make up 33.8 per cent of the county and include the most highly improved land in the area surveyed. General farming and dairying are the leading types of agriculture followed.

it rests upon lighter colored, unassorted till. Considerable gravel and fine rock fragments, 35 to 50 per cent of which are limestone, occur in portions of the subsoil.

The type has some variations, though the areas departing from the typical soil are too limited in extent to be classed separately. On the tops and upper slopes of hills and ridges the surface soil has frequently been eroded, leaving exposed the heavier subsoil, while on the lower slopes the wash from the higher land has accumulated, giving a deeper soil. In these lower places the soil often approaches a silt loam. A light phase is found, usually where the type borders sandy or gravelly soils. In such places both soil and subsoil contain more fine sand than is typical and the structure of the material is looser.

Topography and drainage.—The Miami loam has a gently rolling to rolling topography. Drumlins are numerous and the slopes of some of these are steep enough to cause erosion. The natural surface drainage is good, though there are a few narrow draws and some small depressions where a single line of tile would be beneficial.

Origin.—The Miami loam has been derived from glacial material in the form of ground moraine deposited by the Green Bay Glacier of the Late Wisconsin Ice Sheet. The glacial débris contains considerable limestone material, but the surface soil has been leached to such an extent that the lime has been largely removed and in some places an acid condition has developed. The subsoil, however, is usually found to contain considerable lime. While sorrel is found growing in a number of fields, there is a rank growth of sweet clover along the roadsides over much of the type.

Native vegetation.—The native vegetation on this type consists chiefly of white oak, black oak, maple, some elm, hickory, a little cherry, and ash. The few areas south of the Bark and west of the Rock River were largely "openings." Only about 5 per cent of the type is now in forest, and this is in small woodlots, largely of second growth.

*Present agricultural development.**—Approximately 95 per cent of the type is under cultivation, the type of agriculture being mainly of general farming in conjunction with dairying. A good many hogs are raised. The tendency at present seems to be toward an extension of the dairy industry.

The usual crops grown are corn, oats, barley, hay, alfalfa, rye, and a little wheat. Oats are grown more extensively than any other crop and do well on this soil, giving an average yield of 40 to 45 bushels per acre. Not so large a proportion of this soil is devoted to corn as

* For chemical composition and improvement of Miami loam see page 28.

is the case with the Miami silt loam, yet it produces good crops and yields an average of about 40 bushels per acre. Only a comparatively small amount of barley is grown. The ordinary yield ranges from 25 to 30 bushels per acre. Rye and wheat are grown only to a limited extent. The former yields about 20 to 25 bushels and the latter from 20 to 30 bushels per acre. Owing to the fact that there is so much low, poorly drained land associated with this type, there is not much clover and timothy grown. Clover yields on the average 2 tons per acre, and when mixed with timothy about $1\frac{1}{2}$ tons. Alfalfa is coming to be an important crop. Three cuttings are made each year, the yields ranging from 2 to 4 tons per acre, though as much as 5 tons per acre has been obtained in exceptional cases.

Special crops are not produced to any marked extent. Some potatoes are grown by nearly all farmers, but chiefly for home use. The usual yield is from 125 to 150 bushels per acre. In the extreme southwestern part of the county there is a small area of the Miami loam where tobacco is being produced. From 1,000 to 1,400 pounds per acre is the usual yield.

The crop rotations followed, and methods of cultivation are practically the same as on the Miami silt loam.

FOX SILT LOAM

Extent and distribution.—The type occupies over 12 square miles and is more extensive than any of the other Fox soils in the present survey. It is developed northwest of Fort Atkinson, in the vicinity of Lake Mills, south of Ripley Lake, north of Lake Koshkonong, and east of Hubbleton.

Description.—The surface soil of the Fox silt loam consists of 8 to 10 inches of brownish-gray, friable silt loam. The amount of organic matter present is small, the silt content is sufficiently large to impart a very smooth feel, and with the exception of a few cobbles here and there the soil is free from coarse material.

The subsoil consists of a brownish-yellow silt loam, becoming heavier with depth and passing at 20 inches into a silty clay loam, and into a gritty clay loam at about 30 inches. At depths of 2 to 5 feet, with an average depth of about 3 feet, stratified gravel and sand are encountered. The areas over which they occur at 2 feet are small and could not be separated from the deeper portions on the scale used in the present survey.

In Milford Township the type is underlain at 2 feet by a yellow very fine sand, mottled with gray. The type as a whole is quite uniform, but the depth to stratified material is deeper than typical

for the Fox silt loam. It is very similar in texture and color to the Miami silt loam, but differs from that type in being level and underlain by assorted material instead of till.

Topography and drainage.—In general the topography is level to gently undulating; locally the surface is somewhat pitted. Over the greater part of the type where the underlying gravel comes to within 3 feet or less of the surface the drainage is good, but where the depth of surface material is greater than 3 feet tile drains could doubtless be installed to advantage.

Origin.—The type has been derived from glacial material which has been reworked and redeposited as outwash plains by streams issuing from beneath the ice sheet. It may also occur as a terrace above present flood plains. The surface material was probably deposited in quiet waters and may have been influenced to some extent by wind action. The soil is frequently found to be in an acid condition, but the subsoil contains limestone fragments and is not acid. The gravel underlying the type is about 95 per cent limestone. Sweet clover was seen growing along the roadside over most of the Fox silt loam.

Native vegetation.—The native vegetation consisted chiefly of black, bur, and white oak, though most of the type would be classed as "openings," as the trees were scattered, with considerable areas of prairie grass between them.

*Present agricultural development.**—Probably as much as 98 per cent of the Fox silt loam is under cultivation at present. The type of agriculture followed most extensively consists of dairying in conjunction with general farming and the raising of hogs. The type is well adapted to this system of farming and to the production of all of the general farm crops common to the region. The yields of oats vary from 40 to 50 bushels per acre, though a yield of 70 bushels has been reported. Corn produces from 40 to 55 bushels and barley from 35 to 40 bushels per acre. Clover grows well, yielding about 2 tons per acre when sowed alone, or about $1\frac{1}{2}$ tons per acre when mixed with timothy. Alfalfa makes a satisfactory growth and three cuttings are secured each season, giving a total yield of 3 or 4 tons per acre.

Special crops are not grown to any extent on this type. Potatoes are grown for home use chiefly. Sugar beets thrive and yield about 12 tons per acre, but the acreage is small. The sugar content is higher than in beets grown on the Clyde soils. Peas and corn for canning are grown near Fort Atkinson and good results are obtained. The peas have a sweet flavor, which is desired on the market. Some

* For chemical composition and improvement of Fox silt loam see page 28.

tobacco is grown in the southwest corner of the county, but the amount on this type is very small, though the yields secured are satisfactory.

The rotation of crops most commonly followed consists of corn, barley, and oats one year each, followed by clover and timothy. When barley is not grown oats may be grown for two years following corn. Stubble land is usually plowed in the fall and sod land in the spring. Manure is usually applied to sod land in the winter for corn at the rate of 10 to 15 loads per acre every 4 or 5 years. But little difficulty is experienced in the cultivation of this type and it usually works into a mellow seed bed as readily as the Miami silt loam.

Farms on this type range in value from \$125 to \$200 an acre.

FOX SILT LOAM, DEEP PHASE

This phase is very similar to the Fox silt loam, except that the fine surface material is deeper than is usually included in that type. On account of its depth, the soil has a greater water-holding capacity than the typical Fox silt loam and its agricultural value is considered somewhat higher. It was therefore considered advisable to classify the material as Fox silt loam, deep phase.

A heavy phase was found in a number of places where the surface soil consisting of a heavy silt loam was underlain by a silty clay which becomes very stiff, compact and of a yellowish color below 24 inches. It is quite calcareous and contains numerous lime concretions. The depth to which this heavy material extends is variable, but it is always greater than is found in the typical Fox silt loam. In Sullivan Township, and in the old pre-glacial valley between Oak Hill and Fort Atkinson the heavy subsoil extends to a depth of 40 inches or over, while in the areas north of Jefferson along Crawfish and Rock Rivers, and east of Jefferson Junction along Johnson Creek it is known to extend to a depth of 6 or 7 feet before beds of fine sand are encountered.

The deep phase is of limited extent. Aside from the tracts mentioned above most of this soil is found in Lake Mills and Oakland Townships.

The surface of this phase is level to very gently undulating, and on account of the heavy nature of the subsoil the natural drainage is somewhat deficient. Tile drains would be beneficial especially where the heavy subsoil is the deepest.

A portion of the deep phase of Fox silt loam may be a till plain or it may be glacial outwash material. It is thought that all of the type is underlain by stratified material, but over some of the areas

no cuts or well records could be found, and borings with the soil auger could not reach stratified material. The origin of the extremely heavy material may be comparable with that of the Clyde clay loam—that is of lacustrine origin. It occupies a somewhat higher position, has better drainage conditions, and this would account for a lighter vegetable growth than that which contributed to the black color of the Clyde soils. The sand which is found underlying the type in places, and which is probably continuous, doubtless was deposited in moving waters by streams from beneath the ice sheet.

The native growth consisted of oak, maple, basswood, elm, and some hickory.

About the same proportion of this phase is cultivated as of the typical soil. Yields are frequently somewhat higher but the methods of farming are the same as on the typical soil.

FOX LOAM

Extent and distribution.—The Fox loam is inextensive and occurs chiefly in Sullivan and Concord Townships, with a few scattered areas in other parts of the county.

Description.—The surface soil of the Fox loam consists of a grayish-brown, medium-textured light loam, of low organic-matter content, a rather loose, open structure, and about 10 inches deep. There are no boulders on the surface, but a little gravel is frequently seen scattered over the soil.

The subsoil consists of a yellowish-brown, rather compact, gritty loam, extending to a depth of about 24 inches, where a bed of reddish-brown, loose, water-worn gravel and sand is reached. This material is stratified and extends to 36 inches or more. The layer directly over the sand and gravel is compact and often spoken of by the farmers as “hardpan.”

Patches of sandy loam are often found scattered through the type, but they are too small to be indicated on the soil map. In Milford and Watertown Townships the type is underlain at 24 inches by very fine sandy loam, which at 30 inches rests upon an almost white, calcareous silty clay loam.

A phase somewhat heavier than typical occurs in Lake Mills and Oakland Townships.

Topography and drainage.—The surface of the type is level to gently undulating, and, on account of the loose material underlying it, the natural drainage is excessive. The soil frequently suffers from drought unless the rainfall is equally distributed over the growing season. The heavy phase retains moisture better than the typical soil.

Origin.—The Fox loam has been derived from glacial material which has been reworked by streams flowing from beneath the ice sheet and laid down as outwash plains or terraces. The gravelly subsoil contains a high percentage of limestone, but the lime presumably in the surface material has been leached out and the soil in many places is in an acid condition. Sorrel grows upon many of the fields, but the roadsides support, in places, a good growth of sweet clover.

Native vegetation.—The native vegetation consisted chiefly of white oak and black oak, with some hickory and a little basswood. Practically all the forest has been removed.

Present agricultural development.—Probably over 95 per cent of the Fox loam is under cultivation. It is used mainly for dairying and general farming. Most of the general farm crops common to the region are grown. Oats yield an average of 30 bushels, corn 35 bushels, rye 20 to 25 bushels, and barley about 25 bushels per acre. Rye is grown more extensively on this type than on the heavier soils, but the acreage of barley is relatively small. Clover does well when there is sufficient moisture, but it frequently suffers from drought. The yield of clover and timothy ranges from 1 to 2 tons per acre. As there is considerable lowland associated with the type, only a small acreage is devoted to hay or pasture. But few farmers have succeeded in getting a stand of alfalfa. Potatoes and tobacco, with peas and corn for canning, are special crops grown in a small way.

The rotation most commonly followed consists of corn one or two years, oats one year, followed by clover and timothy. Rye may follow oats for one year. Either fall or spring plowing is practiced, depending chiefly upon the convenience of the farmer. The type can be worked under a wide range of moisture conditions and no difficulty is experienced in getting a good seed bed. Stable manure is the only fertilizer used, but the supply is not sufficient to be applied to all the fields.

CHEMICAL COMPOSITION AND IMPROVEMENT OF MIAMI SILT LOAM, MIAMI LOAM, FOX SILT LOAM AND FOX LOAM.

In texture, structure, and color the types of soil in this group are quite similar. In chemical composition they are also closely related, but some variations have been observed. The Miami silt loam and loam contain approximately 1200 pounds of phosphorus per acre in the surface 8 inches, while the Fox silt loam contains about 960 pounds and the Fox loam a somewhat smaller amount. The phos-

phorus content of this group of soils, especially the Fox soils, is somewhat lower than should be maintained in order to keep up or increase their productivity.

The total amount of potassium present in these soils is ample and ranges from about 30,000 to 40,000 pounds per acre in the surface 8 inches. The problem of the potassium supply is to have a sufficient amount of organic matter to produce the necessary chemical changes in the inert potassium compounds to make them available to plants.

This group of soils has a rather small amount of organic matter and consequently a small amount of nitrogen, the average being approximately 3000 pounds per acre 8 inches for all of the types except the Fox loam, which contains only about 2200 pounds.

The amount of lime or lime carbonate in these soils is variable. As a rule, fields which have been cropped for a number of years have lost nearly or quite all of the lime originally contained in the surface soil, and have in many cases become acid. The subsoil, however, often still contains large amounts of this material, but for the insurance of good growths of plants requiring lime, especially alfalfa, this will have to be supplied in all cases where the surface shows a distinct acid reaction, as indicated by the use of the litmus test or the Truog test* for soil acidity.

In the improvement of this group of soils the factor which may well be given first consideration is a means of increasing the amount of organic matter and the supply of nitrogen. As the supply of stable manure is usually inadequate, it should be supplemented by green manuring crops, of which the legumes are the best. Plowing under a second crop of clover once during each rotation will greatly assist in increasing the productivity of the soil. This will not only increase the supply of nitrogen in the soil but it will also improve the physical structure. The presence of a large amount of organic matter will also assist in making available for the plant a larger amount of potassium, which is present in sufficient quantities in these soils, but which is often in such a form as to be of little use to the plant.

A number of tests have been conducted which indicate that these types of soil will respond readily to the use of ground rock phosphate. This may be applied at the rate of from 500 to 1000 pounds per acre, for the first application and somewhat smaller amounts once during each rotation. It may be applied with a fertilizer distributor the same as ground limestone is sometimes applied, or it

* The "Truog Test" for determining soil acidity is a new method which has been perfected by E. Truog of the Soils Department of the University of Wisconsin, by which the relative degree of acidity can be accurately determined in the field or laboratory in a few minutes' time. For a detailed description of this method write the Soils Department, College of Agriculture, Madison, Wis.

may be sprinkled on top of manure in the manure spreader and scattered over the fields in this way. It may also be sprinkled in the stables during the winter, and taken up with the manure. This is probably the simplest and most effective way of applying ground rock phosphate. In this form the phosphorus is only slowly available so that there will be but little if any loss if larger applications than indicated are given.

Where an acid condition is found to exist on any of these soils this should be corrected by the use of some form of lime. Ground limestone rock will be found very effective, and this may be applied at the rate of at least 1500 to 2000 pounds per acre, and some times considerable more, depending upon the degree of acidity. The limestone may be applied at any convenient time as it is slowly soluble and will remain in the soil for a number of years.

Another factor of importance to be considered in the permanent improvement of these soils is that of thorough cultivation. Plowing should be done when the moisture conditons are favorable, and before a crop is planted the soil should be thoroughly pulverized, and the seed bed in a loose mellow condition. All after cultivation of intertilled crops should be sufficiently frequent to maintain a good surface mulch, to conserve the moisture, and to permit a free circulation of air through the soil.

Attention should be given to the selection of crop rotations best suited to these soils and to the types of farming followed.

A rotation in quite common use consists of corn, one year followed by oats and barley one year each, then by clover and timothy for two years. A leading agricultural authority in the county recommends a rotation consisting of two years corn, one year barley or oats and three to four years of alfalfa, after which the field should be plowed again and planted to corn. The manure may be applied to sod land before plowing for corn. This rotation is giving very good results where followed and should be put into more general practice.

Since the soils of this group cover 37 per cent of the county and include the finest agricultural land in the region, it will be realized that the question of keeping up or of increasing their productivity is one of great importance, and one which should receive the careful consideration and study of every farmer located on these soils.

CHAPTER III.

GROUP OF FINE SANDY LOAM SOILS.

MIAMI FINE SANDY LOAM

Extent and distribution.—The Miami fine sandy loam is one of the important upland types, though it is not as extensive as the silt loam. It is confined chiefly to the southern half of the county, the largest area lying directly south of Fort Atkinson and extending to the county line. Another area of smaller extent is located in southeastern Sullivan and northeastern Palmyra Townships. Small tracts occur in every township in the county, but throughout the northern half the areas are small and scattered. The type is interspersed with a number of small patches of Miami gravelly sandy loam and with areas of Peat or soils of the Clyde series.

Description.—The surface soil of the Miami fine sandy loam consists of a light-brown fine sandy loam with a depth of 8 to 10 inches. Some medium and coarse sand particles are found in the soil and the type in places approaches a medium sand in texture. The material is friable in structure and sometimes loose and porous. The content of organic matter is small. A considerable number of bowlders were originally found upon the surface, but most of these have been removed from the cultivated fields. Over the surface of many areas a sprinkling of gravel occurs and a small amount may be found within the soil mass.

To a depth of about 18 inches the subsoil consists of a brownish-yellow, light-textured loam. Below this it gradually becomes lighter in color, somewhat heavier in texture, and more compact until a sandy clay loam is reached. At 36 to 40 inches the true unsorted till is encountered and this extends to a depth of at least 40 or 50 feet. Lenses of sand frequently occur in the subsoil. The gravelly material, angular fragments, and bowlders found in the subsoil are largely limestone.

There are several variations in the type, but none of these were found to be of sufficient importance to map separately. Most of the areas in Watertown Township are lighter than typical, both in the soil and subsoil. In Milford Township the type is also light. Here the sand is of a finer texture and of a more pronounced yellow color.

A small area in Palmyra Township consists of a light-brown fine sand about 8 inches deep, underlain by a sticky fine sand which becomes a fine sandy loam at about 16 inches. The deep subsoil below 24 to 30 inches contains considerable clay and some fine gravel.

Topography and drainage.—The topography varies from gently rolling to rolling and the type is subject to erosion in only a few places. On account of its topography and the sandy nature of the soil, the drainage is thorough, in places excessive, and the crops may suffer somewhat during dry spells of unusual length.

Origin—The Miami fine sandy loam is of glacial origin. It is derived from the ground moraine. The subsoil is filled with gravel, small rock fragments, and bowlders, mainly limestone. The surface soil has been leached to such an extent that practically all of the lime originally present has been removed and an acid condition was found to exist over nearly all of the type.

The subsoil is frequently found to be slightly acid, but in most cases varying amounts of lime carbonate still remain and have an appreciable influence on the agricultural value of the soil.

Native vegetation.—The native forest growth consisted chiefly of oak, maple, and hickory. A portion of the type was only sparsely forested and was termed "openings." Most of the areas west of the Rock River were in the "openings," where the scattered tree growth was chiefly bur oak and black oak, with a sprinkling of hickory.

*Present agricultural development.**—Probably over 90 per cent of the Miami fine sandy loam is under cultivation. General farming in conjunction with dairying is the leading type of agriculture, though the dairy industry is not as highly developed as it is on the Miami loam and Miami silt loam types. Hogs are raised on most of the farms.

Oats are grown more extensively than other crops. The yields are lower than on the heavier types of the series, 35 bushels per acre being about the average. Corn is an important crop and yields from 25 to 40 bushels per acre. Barley is grown to some extent, but seems to be better adapted to a heavier soil. Yields range from 20 to 30 bushels per acre. Rye is grown on many farms and is well adapted to the type. Only a small acreage is sowed to wheat. In recent years the yields have ranged from 15 to 25 bushels per acre. A mixture of clover and timothy is usually grown for hay and yields of 1 ton to 1½ tons per acre are obtained. When clover is grown alone the yield is somewhat larger. During dry seasons some difficulty is experienced in getting a stand of clover. The number of

* For chemical composition and improvement of Miami fine sandy loam see page 37.



**VIEW OF MIAMI FINE SANDY LOAM, SHOWING TYPICAL SURFACE FEATURES
AND AVERAGE BUILDINGS.**

There are about 30,000 acres of this kind of land in Jefferson County.



VIEW OF RODMAN GRAVEL, SHOWING UNEVEN, PUMPY TOPOGRAPHY

This soil has a very low agricultural value. The view is typical of all soils of the Rodman series found in the morainic region south and east of Palmyra in the southeastern part of the area.

For description of Rodman gravel see page 43.

poorly drained areas from which hay is often cut have the tendency to reduce the acreage which would otherwise be devoted to grasses and clover. Some alfalfa is grown, though not so much as on the heavier types of the series. The usual yield is from 2 to 3 tons per acre, with 5 tons as the maximum reported.

Special crops are grown only to a small extent on this soil. About 100 acres of sweet corn is grown for the canning factory at Fort Atkinson each year. The average yield is from 3 to 3½ tons of snapped ears per acre. Some peas are also grown for the canning factory, but the quality is inferior to that of peas grown on the silt loam. A few sugar beets are produced south of Fort Atkinson, and while the yield is low, being from 8 to 10 tons per acre, the sugar content is larger than in case of beets grown on the silt loam. In the extreme southwest corner of the county a small quantity of tobacco is produced. Potatoes do well on the type, yielding an average of 150 bushels per acre. This crop, however, is not grown to any extent for the market.

The rotation of crops most commonly practiced consists of one year corn, one or two years small grain, followed by two years clover and timothy. If there is no lowland pasture, the hay field is usually pastured the second year. Oats and rye are the small grains most often grown, though barley may be used in the rotation. There are a number of farmers who do not follow any definite crop rotation.

FOX FINE SANDY LOAM

Extent and distribution.—This type, comprising a little more than 8 square miles, is most extensively found in Oakland and Sumner Townships, though small patches occur in various parts of the survey. Small areas having the heavy stratum in the subsoil lie in the preglacial valley along Scuppernong and Bark Rivers between Oak Hill and Fort Atkinson.

Description.—The surface soil of the Fox fine sandy loam to an average depth of 8 inches consists of a light-brown fine sandy loam which contains a large percentage of medium sand. The soil is loose and open in structure and the amount of organic matter present is small. The surface soil is underlain by a brownish-yellow sandy loam extending to a depth of 18 inches, where it grades into a sandy clay. Medium sand is reached at about 30 inches and cuts show this material and the gravel which is found at about 4 feet to be stratified. There are a few places where the subsoil from 24 to 36 inches consists of a very fine sandy loam, but such places are of small extent.

A variation occurs in which the subsoil at about 32 inches is a pale-yellow, stiff, compact silty clay, containing lime concretions. The thickness of this heavy layer was not determined, but it is probably underlain by the stratified sand at 5 to 6 feet.

A heavy phase of this type is found in a few places where both soil and subsoil are heavier than typical. Such areas, however, were too small to be indicated separately on the soil map.

Topography and drainage.—The surface is level to gently undulating, the natural drainage thorough, and during dry seasons the crops are apt to suffer from lack of moisture, though less on the areas with the heavy subsoil layer than elsewhere.

Origin.—The type is derived from glacial débris which has been deposited as outwash material by streams issuing from beneath the ice sheet. It may also occur as terraces lying above present overflow. The surface soil is in an acid condition, though in the deep subsoil there is a considerable quantity of limestone gravel. Sorrel was found growing in most of the fields.

Native vegetation.—Originally the areas were covered with an open forest growth consisting chiefly of black oak, bur oak, and white oak. In the openings in the forest considerable areas supported prairie grass.

*Present agricultural development.**—Over 95 per cent of the Fox fine sandy loam is under cultivation, being devoted to general farming and the production of a few special crops. Oats, corn, rye, and hay are the chief general farm crops grown. Tobacco, potatoes, and peas are the main special crops. Yields of all these are slightly lower than on the Fox loam. It seems to produce a better grade of wrapper tobacco than any of the other types in the county. Where tobacco is grown the most common method of cropping consists of turning under the sod and planting tobacco for two or three years, corn one year, oats one year, followed by clover and timothy for two years. But little hay is produced, as the type is associated with low, poorly drained land which provides marsh hay and pasture.

MIAMI GRAVELLY SANDY LOAM†

Extent and distribution.—The Miami gravelly sandy loam is not so extensive as the Miami loam or fine sandy loam, but it occupies a larger area than the fine sand. The largest tract is found in the southern part of Sullivan Township. Concord, Cold Spring, and

* For chemical composition and improvement of Fox fine sandy loam see page 37.

† Because this type is similar in chemical composition and has about the same value as the fine sandy loams it has been included with the fine sandy loam group of soils.

Koshkonong Townships contain a number of smaller areas and a few scattered patches are to be found in every township in the survey.

Description.—The surface soil of the Miami gravelly sandy loam consists of a grayish-brown sandy loam to heavy sandy loam 8 inches in depth. Where typically developed the material is friable and the structure is rather loose. There is frequently a sprinkling of gravel on the surface and it is often found throughout the soil section. Boulders were originally numerous on the surface, but most of the largest ones have been removed from the cultivated portions of the type.

The subsoil consists of a reddish-brown, gritty clay loam, extending to a depth of about 22 inches, below which it becomes more sandy and gravelly. The upper subsoil is often quite compact, though it may contain some gravel and stones. The unassorted till contains considerable gravel, stones, and boulders and a large percentage of these are of limestone.

Variations in the type are numerous, but usually of minor importance. On the hill tops and steeper slopes the surface material has frequently been eroded away and the underlying compact subsoil exposed. In such places the surface is heavier than typical. Along the lower slopes the surface is deeper than ordinary, owing to the wash from the slopes above. A few areas were noted where the surface soil approached a loam, but such tracts were of only small extent. In a few localities the surface soil was lighter and deeper than typical—a loamy sand with gravel—but the subsoil in such places was sufficiently heavy to make a change in classification unnecessary.

Topography and drainage.—The surface of the type is gently to steeply rolling and the natural drainage is thorough, sometimes excessive, crops frequently suffering from lack of moisture. The steep slopes are subject to erosion and in many places gullies have been formed in the hillsides. The type often occurs as long, narrow ridges, as drumlins, or as a capping of hills.

Origin.—While the Miami gravelly sandy loam is derived chiefly from the ground moraine, some of the areas appear to have their origin in materials of recessional moraines. The underlying material consists of unassorted glacial till. Leaching has carried away most of the lime carbonate from the surface soil and an acid condition is sometimes found to exist. The subsoil, however, usually contains considerable lime.

Native vegetation.—The native forest growth consisted chiefly of bur oak, white oak, black oak, hickory, and some maple. Some of

the type is still covered with trees, which are valued chiefly as a source of fuel.

*Present agricultural development.**—About 25 or 30 per cent of the type is under cultivation at present, the remainder being in pasture and wood lots. The largest cultivated area is in Sullivan Township, but even here much of the type is not under the plow. The Miami gravelly sandy loam is frequently found associated with some better soil which may be used for the cultivated crops and the former for pasture. The grazing is good in early summer, but later the grass frequently dries up and furnishes but little pasture.

Oats, hay, rye, corn, a little wheat, and barley form the principal crops on this soil. Oats are grown more extensively than other grains. From 25 to 40 bushels per acre is the ordinary range in yields. The yield of corn is about 35 bushels, rye 20 to 25 bushels, wheat 15 to 25 bushels, and barley 20 to 30 bushels per acre. Clover and timothy do fairly well, but are not grown extensively. June grass is the principal pasture grass. Considerable alfalfa is grown, and in most instances it does very well. Special crops are not grown to any extent upon the Miami gravelly sandy loam. A few potatoes are produced, but only for home use.

While many farmers do not practice a definite crop rotation, the one most commonly followed consists of corn one year, small grains two years, and clover and timothy two or more years. Where alfalfa is grown it is allowed to remain from three to five years.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Miami gravelly sandy loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Soil.....	0.8	12.6	20.5	19.4	6.2	34.5	6.1
Subsoil.....	1.9	12.1	20.2	22.3	7.7	26.7	9.1

RODMAN FINE SANDY LOAM

Extent and distribution.—This soil is of very small extent and occupies less than one-half square mile. It is found in Palmyra Township, where it forms a part of the Kettle Moraine. A small patch also occurs in Oakland Township.

Description.—The surface soil of the Rodman fine sandy loam consists of a light-brown fine sand, extending to a depth of about

* For chemical composition and improvement of Miami gravelly sandy loam see page 37.

6 inches. The material is loose and open and contains only a very small quantity of organic matter. The subsoil is a reddish-brown, sticky sandy loam to a depth of 30 inches, where a bed of stratified sand and gravel is encountered.

The type is similar to the light phase of the Miami fine sandy loam in texture, structure, and color, but differs from that soil in origin and in being underlain by stratified material instead of till, which makes it more subject to drought.

Topography and drainage.—The topography is rolling and the natural drainage excessive, causing the crops to suffer from drought nearly every year.

Origin.—The material composing the type consists of assorted glacial débris which was deposited beneath the ice sheet chiefly in the form of kames and eskers. While the gravel in the subsoil contains much limestone, the surface soil is in an acid condition, and fields support a growth of sorrel.

Native vegetation.—The native forest growth consisted chiefly of scrub oak. Most of this has been cut and the land placed under cultivation.

Present agricultural development.—About 90 per cent of the Rodman fine sandy loam is under cultivation. It is used for general farming, although better adapted to truck crops. The chief crops grown are corn and rye, but the yields are low. It is difficult to get a stand of clover, on account of the acid condition and droughty nature of the soil.

The agricultural value of this type is probably slightly inferior to that of the Miami fine sandy loam.

CHEMICAL COMPOSITION AND IMPROVEMENT OF MIAMI FINE SANDY LOAM, MIAMI GRAVELLY SANDY LOAM, FOX FINE SANDY LOAM AND RODMAN FINE SANDY LOAM

Chemical analyses indicate that the soils of this group contain smaller amounts of all the essential plant food elements than are found in the group of heavy, light colored soils. The phosphorus content is variable, but in the Miami fine sandy loam, which is by far the most extensive type in the group, there is approximately 900 pounds for the surface 8 inches per acre. The Miami gravelly sandy loam is about the same, while the samples of the Fox and Rodman fine sandy loams analyzed indicate that these types contain a considerable lower amount of phosphorus.

The supply of potassium present in this group of soils may be considered as a fair amount, and sufficient for the demands of grow-

ing crops, when proper methods of cultivation are followed. The amount present ranges from 25,000 to 35,000 pounds per acre in the surface 8 inches.

The amount of organic matter and nitrogen in these soils is more uniform than the phosphorus supply, but the total amount is comparatively small. The amount of nitrogen present is only about half that found in the Miami loam and silt loam types, the total supply being approximately 1500 pounds.

The lime content of these soils was originally high, many of the coarser particles being made up of limestone. The surface soils however, have been leached to a considerable extent so that in places an acid condition is found to exist. The subsoils are seldom acid. Each farmer should have his soil tested for acidity to determine the need of lime, especially for the growth of clover and alfalfa. An acid condition may be readily corrected by the use of ground limestone, the amount required depending upon the degree of the acidity. It is doubtful if more than one ton per acre would be required to correct the most pronounced cases of acidity in this group of soils.

One of the greatest needs of the soils in this group is a larger supply of organic matter. This may be supplied by supplementing the stable manure with green manuring crops of which legumes are best. This decaying vegetable matter will increase the water-holding capacity of the soil, and it will also assist in making available for the plants the potassium which is now securely locked up by various chemical combinations.

The phosphorus supply may be increased by the use of ground rock phosphate, which should be applied at the rate of 500 or 600 pounds per acre for the first time, followed by smaller amounts once during each crop rotation.

Careful attention should be given to the selection of crop rotations best suited to these soils. Where the location is suitable, and where there are adequate facilities for marketing, the trucking industry could well be developed on a commercial scale. Bush berries and strawberries thrive and their culture should be encouraged. Where general farming and dairying are the chief lines of agriculture followed, as is usually the case, the growing of alfalfa should be extended after the soil has been made productive, and inoculated.

CHAPTER IV.

GROUP OF FINE SANDS AND GRAVELLY SOILS.

MIAMI FINE SAND*

Extent and distribution.—This type is of very small extent in the present survey. It is confined almost entirely to the southeastern part of the county. The largest tract lies in the immediate vicinity of Palmyra.

Description.—The surface soil of the Miami fine sand to a depth of 6 or 8 inches consists of a loose, light-brown fine sand, containing little organic matter. The subsoil consists of a loose, yellow fine sand. A little gravel may be scattered upon the surface and mixed with soil and subsoil, though typically they are usually free from coarse material. When unprotected the soil drifts to some extent.

Topography and drainage.—The type is very gently rolling, except in Palmyra Township, where it has a somewhat rougher surface. The natural drainage is excessive and the type droughty.

Origin.—The material composing the Miami fine sand is derived from glacial débris forming the ground moraine. An acid condition was found to exist in the surface soil in practically the whole type.

Native vegetation.—The original timber growth consisted chiefly of red, bur, and white oak, with some hickory. The tree growth, however, was not as thrifty as on the heavier types of soil.

Present agricultural development.—Over 90 per cent of the Miami fine sand is under cultivation at present, the remainder being in wood lots. Dairying and general farming are the chief types of agriculture followed. Most of the crops common to the region are grown, but the yields are low. Corn yields from 10 to 20 bushels, rye from 10 to 12 bushels, and clover from one-fourth ton to a ton. Oats and barley are not grown to any extent. Cucumbers and potatoes are special crops. The former do very well, giving gross returns of \$125 to \$150 an acre. While the latter are of good quality, the yields are low.

* For chemical composition and improvement of Miami fine sand see page 44. In the future soil of this character will be correlated with Coloma fine sand since the lime carbonate in subsoil is lacking or in such small amounts as to be of no agricultural value.

PLAINFIELD FINE SAND

Extent and distribution.—The type is of relatively small extent, occupying only a little more than 1,000 acres in the whole county. The largest area is in the immediate vicinity of Oak Hill. Other patches occur chiefly in Palmyra Township, though there are a few small tracts in other parts of the survey.

Description.—Plainfield fine sand consists of a loose, light-brown fine sand, 6 inches deep. It is underlain by a loose, yellow fine sand, which is stratified. The soil contains little organic matter.

Topography and drainage.—The surface is flat to gently undulating, and the drainage is excessive. Crops frequently suffer from drought, especially during the late summer.

Origin.—Plainfield fine sand is derived from glacial material which has been deposited as outwash plains or as small terraces by streams coming from beneath the ice sheet.

While this material comes from a glaciated limestone region it has been acted upon by water to such an extent that the lime carbonate content is very low, and the soil acid. On account of this condition the soil is classed as Plainfield rather than Fox.

Native vegetation.—The original timber growth consisted chiefly of scrubby oak. Most of this has been removed, and the growth which remains has no merchantable value.

*Present agricultural development.**—Most of the type is under cultivation, and general farming and dairying are practiced. Owing to its small extent, no farms are found exclusively on it. Oats, corn, rye, and some hay are grown. It is difficult to get a good stand of clover. Yields of all the crops are low.

PLAINFIELD SAND†

Extent and distribution.—This type is inextensive, the largest areas lying in the vicinity of Oak Hill. A few smaller areas occur, chiefly in Sullivan Township.

Description.—The surface soil of Plainfield sand consists of 6 inches of light-brown medium sand, which is loose and porous and contains but little organic matter. It is underlain by a loose, brownish-yellow medium sand, which in many places becomes finer with depth. At 20 to 24 inches the material may be slightly sticky, but at 30 to 36 inches a bed of stratified sand is found. In one place stratified gravel was reached at 2 feet.

* For chemical composition and improvement of Plainfield fine sand see page 44.

† For chemical composition and improvement of Plainfield sand see page 44.

Because of its limited extent and close relation to the fine sands this type has been included with the fine sand group.

Topography and drainage.—The surface is level to gently undulating, and the natural drainage is excessive. The loose, open structure of the material permits the rain water to escape rapidly, and crops suffer from drought, except during seasons of excessive rainfall.

Origin.—The type is derived from glacial material laid down as outwash plains or as terraces above the present flood flow. While this material is found in a glaciated limestone region the lime has been leached out and the soil is now in an acid condition. On account of this acid condition it is classed as Plainfield rather than as Fox.

Native vegetation.—The original forests consisted chiefly of red and white oak, though the growth was somewhat scrubby and scattered.

Present agricultural development.—About 90 per cent of the Plainfield sand is under cultivation. The area of the type is so small that no farms and but few fields are located entirely on this one soil. It is difficult, therefore, to get accurate records of yields. General farming and dairying are practiced, and corn, rye, oats, and a little clover are the chief crops grown. All yields are low.

Below are given the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Plainfield sand.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Soil.....	0.3	13.0	40.4	29.0	2.5	9.0	5.0
Subsoil.....	.5	14.2	32.5	35.1	4.2	7.2	6.1

RODMAN FINE SAND

Extent and distribution.—The type is also of small extent, occupying 2.8 square miles. It occurs associated with the Kettle Moraine in Palmyra Township in the southeastern part of the county.

Description.—The surface soil of Rodman fine sand consists of 6 inches of light-brown fine sand, of loose, open structure and low organic-matter content. The subsoil is a loose, open yellow fine sand, showing stratification at lower depths.

Topography and drainage.—The surface is rough and hummocky, the result in part of drifting. Several sand dunes 30 feet in height were seen on the type. The natural drainage is excessive and the type is droughty.

Origin.—Rodman fine sand is composed of glacial material which appears to have been deposited beneath the ice sheet. While most of the gravel and stones present are limestone, the material has been leached so that the surface soil is in an acid condition and sorrel was seen growing in all of the fields.

Native vegetation.—The native forest growth was scattering and consisted chiefly of scrub oak.

*Present agricultural development.**—About 50 per cent of the type is under cultivation, approximately 10 per cent is in forest of scrubby oak, and the remainder is cleared, but not cultivated, because of its low productiveness. General farming is practiced, but the yields are small. Corn, oats, and rye are the chief crops. Clover is difficult to seed and but little is grown, as during dry years the yields are very low and the crops sometimes an entire failure. Of the special crops grown, cucumbers, melons, and potatoes may be mentioned. With an abundance of rain in August and September cucumbers are usually a profitable crop, provided the field has been well fertilized. Melons and potatoes of good quality are grown, but the acreage is very small.

RODMAN GRAVELLY SANDY LOAM

Extent and distribution.—A little more than 4 square miles of this soil is found in the county. It occurs in the southeastern part associated with the Kettle Moraine, and in the western part, chiefly in Oakland Township.

Description.—The surface soil of Rodman gravelly sandy loam consists of a light-brown medium sandy loam, about 8 inches deep, containing a considerable quantity of gravel and only a little organic matter. The subsoil is a reddish-brown, sticky, rather compact gravelly sandy loam, with a depth of 18 inches, resting on stratified gravel. Where the type occurs within the sandy regions of the county the lower slopes are sandy and the surface soil is deeper than typical. Within the silty areas the lower slopes contain considerable silt and are better farm lands. These variations were of too small extent to be shown as separate types on the map.

Topography and drainage.—The surface is gently to steeply rolling and the natural drainage excessive.

Origin.—The type consists chiefly of kame and esker material. The stratified material contains a large proportion of limestone gravel, but the surface soil is frequently in an acid condition.

* For chemical composition and improvement of Rodman fine sand see page 44.

Native vegetation.—As on the Rodman types the original timber growth was scattering. It consisted chiefly of scrub oak, which had but little value.

*Present agricultural development.**—About 35 per cent of the type is under cultivation and the remainder is in forest and pasture land. The chief crops are corn, oats, and rye, but the yields are so small that the type has a low agricultural value. The pasturage is fair during the early summer, but later in the season the grasses wither and dry and furnish but little grazing. It is difficult to get a good stand of clover and but little is grown.

RODMAN GRAVEL†

Extent and distribution.—The type occupies a total area of 6.5 square miles and occurs chiefly in the southeastern part of the county in Palmyra Township, where it forms a part of the Kettle Moraine. It also occurs in the western tier of townships and in a few scattered areas throughout the county.

Description.—Rodman gravel to a depth of 1 to 3 inches consists of a dark-brown medium sandy loam containing varying amounts of gravel and a considerable quantity of organic matter, underlain by stratified material consisting of coarse sand, gravel, stones, and boulders. The structure of the subsoil is very loose and open and there are but few particles smaller than coarse sand. Road cuts show this material to extend to a depth of 50 feet.

Within the Kettle Moraine the depressions in the type are sandy and the soil is considerably deeper than on the hilltops. In the western part of the county the soil in many of the depressions is silty at the surface, and here the type has some agricultural value. These variations, however, were too small to be indicated on the map.

Topography and drainage.—The type is very irregular, occurring as rounded hills and knolls, as long, narrow ridges, and as rough regions dotted with kettle holes from 50 to 100 feet deep. The natural drainage is excessive.

Origin.—Rodman gravel is of glacial origin and consists of water-laid material, chiefly in the form of kames and eskers. In the southeastern part of the county about 95 per cent of the gravel and boulders consists of limestone, while in the western part there is a considerable admixture of Baraboo quartzite.

Native vegetation.—The native forest growth consisted of scrubby oak, with some hickory.

* For chemical composition and improvement see page 44.

† For a typical view of this type of soil see page 44.

Present agricultural development.—On account of the uneven topography, the loose, open structure of the material, and its extremely droughty condition, the Rodman gravel may be considered nonagricultural. Practically all of the type is in forest, but as the growth is scattering some grazing is afforded, and this is the only use that is made of the type so far as agriculture is concerned. In the early spring, when there is plenty of rain, there is a good growth of grass, but later in the summer this dries up and is of no value for grazing.

CHEMICAL COMPOSITION AND IMPROVEMENT OF FINE SANDS AND GRAVELLY SOILS

As is generally true with sandy soils the types of this group are low in their content of all of the essential plant food elements. The total amount of phosphorus in the surface 8 inches is about 900 pounds; of potassium between 25,000 and 30,000 pounds and of nitrogen approximately 1650 pounds. There is but little lime carbonate in the soil to a depth of 3 feet, except that which is in the form of coarse sand or gravel, and hence of relatively little value in preventing the development of acidity in the soil. The Rodman gravel is made up almost entirely of limestone gravel, and is of little value for agricultural purposes.

In order that the fertility of these soils may be maintained or increased it will be necessary to increase the nitrogen and organic matter by applying stable manure, peat, or by the growth of legumes, or by green manuring. For the growth of these legumes, as for other crops, available plant food containing both potassium and phosphorus must be used. By neutralizing the soil acidity with ground limetstone, and by the use of moderate amounts of fertilizers good crops of legumes such as clover, or the annual legumes—cow-peas, soybeans, and yellow lupines—may be grown so as to greatly increase the organic matter. When a good supply of active organic matter has thus been developed, the need for applications of potash fertilizer will largely disappear, though the need of phosphate will doubtless continue. Most of these types are well adapted to the raising of truck crops, and where the location and marketing facilities are adequate this industry could well be extended. Potatoes, strawberries, cucumbers, melons, tomatoes, and the like could be profitably grown to a much greater extent than they are at the present time.

CHAPTER V.

SOILS OF THE PRAIRIE REGION.

CARRINGTON SILT LOAM

Extent and distribution.—This type is developed only to a small extent in this survey, less than a square mile being mapped, and it is not as typical as where it occurs in extensive tracts, as in Dane County to the west and Dodge County to the north. The small areas in Jefferson and Sumner Townships form the main portion of the Carrington silt loam as found in Jefferson County.

Description.—Carrington silt loam consists of about 12 inches of dark-brown to nearly black, friable silt loam, containing a considerable quantity of organic matter, underlain by a yellowish-brown, heavy silt loam, which at about 24 inches grades into a compact silty clay loam. The unassorted glacial till is found at 3 to 4 feet and the underlying rock varies from 10 to 20 feet below the surface.

Topography and drainage.—The surface is undulating to gently rolling and the natural drainage is fairly good.

Origin.—The soil has been derived from glacial till material. Loessial material may possibly form a part of the soil. The dark color is due to the growth and decay of vegetation, chiefly grasses, under poor conditions of drainage. The surface material is in a slightly acid condition and sorrel was found growing in some of the fields.

Native vegetation.—Carrington silt loam is typically a prairie soil, but as found here it supported a scattering growth of oak and was locally called "oak openings."

*Present agricultural development.**—Practically all of the type is under cultivation and it is a very good general farming soil. Corn, oats, clover, and timothy are the chief general farm crops, and very satisfactory yields are secured. The methods of cultivation and fertilization are practically the same as are followed on the Miami silt loam.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

* For chemical composition and improvement see page 47.

Mechanical analyses of Carrington silt loam.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Soil.....	0.0	0.8	1.6	2.8	3.7	73.1	17.8
Subsoil.....	.0	.3	1.0	2.2	4.4	74.1	17.9

CARRINGTON LOAM*

The surface soil of Carrington loam consists of a black, friable loam, about 12 inches deep, containing a considerable amount of organic matter. Beneath this occurs a yellowish-brown, gritty clay loam, gradually becoming lighter in color and in texture with increase in depth. At 30 inches there is considerable limestone gravel in the subsoil, and at about 40 inches the typical glacial till is encountered. Bedrock is reached from 2 to 10 feet below the surface.

The type covers an area of only 448 acres. It occurs in Cold Spring Township and extends south into Walworth County, and has a value of \$135 to \$150 an acre. Its small extent makes it unimportant locally, though in other parts of the State it is a valuable asset.

CARRINGTON FINE SANDY LOAM†

The Carrington fine sandy loam has a small area, comprising less than a square mile in Sumner Township.

The surface soil of Carrington fine sandy loam consists of about 10 inches of dark-brown to black fine sandy loam. On the tops of the knolls the color is lighter than usual, the soil is shallow, and there is a sprinkling of gravel. The subsoil is a brownish-yellow, sticky fine sandy loam to a depth of 30 inches, where a yellow fine sand is reached. Gravel in the subsoil is quite common.

The surface is gently rolling and the natural drainage is very good, though the type is apt to suffer from drought during dry seasons.

The soil has been derived from the ground moraine, and the dark color is due to the presence of relatively large quantities of organic matter. While the subsoil contains considerable limestone material, the surface has been leached, and the soil is now in an acid condition. It was formerly "oak openings."

* For chemical composition and improvement see page 47.

† For chemical composition and improvement of this type see page 47.

About 90 per cent of the type is under cultivation, the remainder being in woodlots. General farming is carried on, though tobacco is one of the important crops grown, and yields from 1,000 to 1,200 pounds per acre. Land of this character sells for \$70 to \$90 per acre.

WAUKESHA LOAM

Extent and distribution.—Less than a square mile of this soil is found in Jefferson County. It is confined to the northeastern part of Palmyra Township, in sections 1 and 12.

Description.—Waukesha loam consists of 10 inches of dark-brown to black, friable loam, underlain by a brownish, rather compact gritty clay loam to a depth of 20 to 24 inches, where stratified beds of gravel are encountered. The type is similar to the Fox loam differing only in color and in content of organic matter, which is larger in the Waukesha loam.

Topography and drainage.—The surface is level to gently undulating, and on account of the underlying gravel the natural drainage is good. The type suffers from drought, especially during the late summer.

Origin.—The type here occurs as a terrace formation, though it may also occur as, or be derived from, outwash plain materials. In any event it is composed of glacial material deposited by streams flowing from beneath the ice sheet. The gravel contains a large percentage of limestone, but the surface soil is in an acid condition.

Native vegetation.—A much larger area of this soil is found in Waukesha County, where it is a prairie soil. In Jefferson County there was a scattering growth of bur oak on the areas, and they were known as "openings."

Present agricultural development.—Practically all of the type is under cultivation and is devoted to general farming and dairying. As it is of small extent, no farms are located entirely upon it. The usual crops are corn, rye, oats, and hay, and fair yields are obtained. Owing to the acid condition of the soil it is difficult to get a good stand of clover. No special crops are grown, except a few potatoes and a little garden truck for home use.

CHEMICAL COMPOSITION AND IMPROVEMENT OF SOILS OF THE PRAIRIE REGION

The soils included in this group are all of very limited extent in Jefferson County, the total area of the entire group being approximately 1200 acres. The content of phosphorus is considerable higher than in the light colored soils of the same texture. In the

Waukesha loam, Carrington loam, and silt loam, the amount is approximately 1600 pounds per acre for the surface 8 inches, while in the Carrington fine sandy loam the amount is somewhat lower. The larger amount of organic matter characterizing this group is probably the cause of the accumulation of somewhat larger amounts of phosphorus than are found in other types of soil having less humus.

The content of potassium in this group of soils is sufficiently high to meet the demands made upon it by crops for an almost indefinite period, the amount being approximately 40,000 pounds per acre in the surface 8 inches. The problem in connection with potassium supply is to keep in the soil a sufficient amount of active organic matter which will assist in making the potassium available to growing plants.

The amount of organic matter and nitrogen is much higher than in the light colored soils of the area, as would be suspected from the dark color. The total supply of nitrogen is approximately 4800 pounds. Where fields have been under cultivation for a long period of years, however, the humus is often of a resistant character which does not decompose readily, and therefore does not serve the purpose of fresh vegetable matter.

All of the soils of this group are in an acid condition, and this should be corrected by the application of ground limestone. The amount required will range from 2000 to 4000 pounds per acre, depending upon the degree of acidity.

In the improvement of these soils the use of ground rock phosphate will be found profitable. About 600 pounds per acre will be found sufficient for the first application. Smaller amounts may then be applied once during each succeeding rotation.

As the humus is in a resistant form the organic matter supply of these soils should be supplemented by fresh vegetable matter in the form of green manuring crops, of which legumes are best. Green manuring crops may be used to supplement the supply of stable manure, and this combination along with rock phosphate will materially increase the productivity of the soils of this group.

CHAPTER VI.

DARK COLORED, POORLY DRAINED SOILS.

CLYDE CLAY LOAM

Extent and distribution.—This type occupies an area of 20.1 square miles, and is confined entirely to the southern part of the county. It lies parallel with and mostly on the south side of Scuppernong and Bark Rivers between Palmyra and Fort Atkinson. It is associated with other low-lying areas of Clyde loam, some Clyde silt loam, and extensive areas of Peat.

Description.—The surface soil of Clyde clay loam to an average depth of 12 to 14 inches consists of a black silty clay loam containing a high percentage of organic matter. The material is quite stiff and compact, but the organic matter present tends to make it more loamy than the light-colored soils containing the same amount of silt and clay.

The subsoil consists of a light-gray or bluish, heavy, plastic, calcareous silty clay, which is somewhat mottled with yellow, especially in the lower depths. With depth the material becomes heavier and more compact, and at 2 to 3 feet it is a compact, impervious, putty-like clay. Some lime concretions and iron stains are commonly found in the deep subsoil. The type as a whole is very uniform.

Topography and drainage.—The surface of the type is flat to very gently undulating and drainage is defective. The rain water drains off fairly well from most of the soil, but there are some depressions and narrow strips along streams where the surface is flooded at times. In addition, the material composing the type is so heavy and compact that the internal movement of water is slow. A number of open ditches and some tile drains have been installed on portions of this soil.

Origin.—The type occupies what is probably an old preglacial valley which was a lake for a time after the retreat of the last ice sheet. The soil thus is of lacustrine origin, the materials of which it is composed having been eroded from higher glacial debris and laid down in quiet waters. To this has been added a large quantity of vegetable matter, which is responsible for the black color of this soil.

Native vegetation.—The original forest growth consisted chiefly of elm, some bur oak, and willow. Where the drainage was the most defective the tree growth was light, but there was in such places a dense growth of wild grasses.

*Present agricultural development.**—At the present time about 75 per cent of the type is under cultivation, the remainder being chiefly in permanent pasture. Dairying in conjunction with general farming is the type of agriculture chiefly followed. From 15 to 25 cows and from 25 to 60 hogs are kept on each 100 acres of land. The leading crops are corn, oats, barley, and hay. Corn does very well, except in wet years, and is the most important crop. Yields range from 35 to 50 bushels per acre, the higher returns being obtained on well-drained areas. Oats average about 45 bushels per acre, with reported yields as high as 75 bushels. Some barley is grown, with an average yield of 35 bushels per acre. The growth of straw in the case of all small grains is apt to be too rank and there is danger of lodging. The quality of the grain is not equal to that grown on the upland soils. Where the type is well drained clover gives very good returns, but the acreage devoted to this crop is small, owing to the fact that there is considerable permanent pasture on the type made up of wild grasses, which are frequently cut for hay. Timothy also does well on this soil.

No special crops are grown upon Clyde clay loam, except a few potatoes and garden vegetables for home use. The potatoes yield well, but are of poor quality, being rather watery and frequently large and hollow.

On this type the most common rotation consists of two years corn, one year oats or barley, followed by clover or timothy. Fall plowing is quite general, owing to the wet conditions which usually prevail during the spring months. Manure is usually applied to sod which is to be plowed for corn. Twelve loads per acre every 4 or 5 years is about the usual application. This type is one of the most difficult to cultivate in the county.

CLYDE SILT LOAM

Extent and distribution.—Clyde silt loam is one of the extensive and important agricultural soils of the county. The largest area occurs along the Crawfish River, extending north from Favilles Grove past Hubbleton and north into Dodge County. This region is usually spoken of as "prairie." Other areas, several square miles in extent, are found north of Lake Koshkonong in Sumner Town-

* For chemical composition and improvement of Clyde clay loam see page 55.



VIEW OF CLYDE SILT LOAM SEVEN MILES WEST OF WATERTOWN.

The Clyde loam, silt loam, and clay loam combined cover over 20 per cent of the county. These types are low, level, and deficient in drainage. When drained they are very fertile, productive soils. The improvement of this class of land is of great economic importance to Jefferson County.

ship and to the west and southwest of Fort Atkinson in Koshkonong Township. Other smaller tracts, containing from a few acres to 2 square miles, are scattered throughout the county. They occur most frequently in the regions where the upland soil is Miami loam or Miami silt loam. Many areas consist of long, narrow strips between tracts of higher land.

Description.—The surface soil of Clyde silt loam as found in Jefferson County consists of a black, friable silt loam extending to a depth of 12 to 15 inches. The soil contains a high percentage of organic matter and silt, which gives it the smooth feel characteristic of the type.

The subsoil consists of a light-gray, heavy silt loam or silty clay loam to 24 inches, where a compact silty clay loam is reached. This material becomes very stiff and tenacious at 30 to 36 inches. The subsoil is frequently mottled and streaked with iron stains and contains considerable lime, some of which is in the form of concretions and crusts. In a few cases seams of fine to medium sand are found in the subsoil and in local areas the surface may be covered with 2 to 4 inches of Peat.

A lighter phase occurs south of Hubbleton, in sections 4, 5, 8, 9, 16, 20, and 21 east of Crawfish River and sections 6, 7, 17, and 18 west of Crawfish River, in Milford Township. Here the subsoil is a light-gray or almost white silty clay loam to a depth of 24 to 40 inches, where a very fine light-gray sand is encountered. In some places this bed of sand can not be reached by the auger, but it is thought to underlie the area in Milford Township at some depth. A similar condition is found in sections 20, 30, and 31, Palmyra Township.

The type somewhat resembles Clyde clay loam, but contains considerably less clay, which makes it an easier soil to handle and more desirable for farming.

Topography and drainage.—Areas of this type are flat, or have only a gentle slope toward the streams along which they occur. The natural drainage is defective, except over a portion of the type along Crawfish River where there is enough slope to give the surface fairly good drainage. The under-drainage of the whole type is defective.

Origin.—Where typically developed Clyde silt loam consists of glacial material which has been washed from the uplands and laid down as a lacustrine deposit in quiet waters. The dark color is due to the slow decomposition of vegetation in the presence of moisture. The portion of the type which occurs along small streams, or as narrow strips between regions of higher land, may be partly alluvial in origin and there may also be some colluvial material mixed with

the soil in places. From the standpoint of texture, color, and agricultural value, however, the differences are not sufficient to warrant a separate classification. The soil is not acid and there is a high percentage of lime in the subsoil.

Native vegetation.—The native forest growth consisted chiefly of elm, some oak, hickory, soft maple, ash, and willow. Along the Crawfish River there was but little forest, and a rank growth of marsh grass covered the lowlands of that section.

*Present agricultural development.**—Only about 10 to 15 per cent of the Clyde silt loam is under cultivation at the present time, about 5 per cent is still in forest and the remainder mostly in pasture and hay lots. In only a few instances have tile drains been installed, though most of the type has been sufficiently supplied with open ditches to be used for pasture and hay. Directly east of Favilles Grove about 300 acres have been tile drained. There are a few other smaller tracts in various parts of the county which have been similarly reclaimed. In sections 6, 8, 9, 17, and 18, Milford Township, about half of the type is drained sufficiently to permit the raising of general farm crops.

General farming in connection with dairying is the chief type of agriculture, with corn, oats, and hay as the principal crops. Of these corn is the most important. The soil is well adapted to this crop, the average yield being about 45 bushels per acre, with yields of 60 bushels frequently reported. Oats do well, though the growth of straw is apt to be so heavy as to cause lodging. The average yield is about 45 bushels per acre. Where the type is well drained clover yields from 2 to 3 tons per acre. Timothy also does well, though not grown extensively. As the type is usually associated with highly improved upland soils, the undrained portions are used chiefly for hay and pasture. Marsh hay yields from 1 to 2 tons per acre. Special crops are not grown to any extent on this type at present, though some peas and a small amount of corn for canning are produced southwest of Fort Atkinson. Both crops give satisfactory yields. As a rule no definite crops rotation is practiced on this type, as so small a portion of it is under cultivation on any farm.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

* For chemical composition and improvement of Clyde silt loam see page 55.

* *Mechanical analyses of Clyde silt loam.*

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Soil.....	0.1	1.0	0.8	3.5	5.3	72.2	17.2
Subsoil.....	.7	1.1	.5	1.2	3.1	74.5	18.8

CLYDE LOAM

Extent and distribution.—Clyde loam is of smaller extent than the silt loam. It occurs only in small patches and is confined largely to Sullivan, Palmyra, Hebron, Cold Spring, Koshkonong, Sumner, and Oakland Townships, though a few small areas occur in the northern part of the county.

Description.—The surface soil of Clyde loam consists of 14 inches of black mellow loam containing a high percentage of organic matter. In a number of places the surface is covered with a few inches of Peat or Muck, but this mantle is never so thick as to prevent the plow turning up the underlying soil. The subsoil consists of a light gray, gritty clay loam, usually mottled with iron stains. This extends to a depth of 3 feet or more, but it may contain seams of sand at almost any depth.

Practically all of the type as found in Palmyra Township is lighter than typical and consists of a black loam from 18 to 20 inches deep, containing a relatively large quantity of fine sand. This is underlain by a yellowish mottled very fine sand. Scattered throughout the type are small patches of Clyde very fine sandy loam too small to map.

Topography and drainage.—The surface of the type is low and flat and the natural drainage is poor.

Origin.—The soil is derived from glacial material occupying old lake beds and occurs along the bottom land bordering streams. A portion of it is lacustrine, but in the small, narrow areas some may be of alluvial and some of colluvial origin. The wet condition prevailing in the past has favored the growth and decay of vegetation, and this accounts for the high organic-matter content and the dark color of the soil. The soil and subsoil contain considerable lime and are not in an acid condition.

Native vegetation.—The native vegetation on Clyde loam was chiefly elm, black ash, willow, and marsh grass.

*Present agricultural development.**—By far the greater proportion

* For chemical composition and improvement of Clyde loam see page 55.

of this type is utilized for pasture and marsh hay. Not more than 5 per cent is under cultivation and probably an equal amount is in forest. Where the type is drained and cultivated, corn and oats are the chief crops. Corn yields from 30 to 50 bushels and oats 30 to 45 bushels per acre. Timothy and alsike clover also do well. Grains are apt to lodge, and the quality of the grain is not so good as that grown on upland soils.

CLYDE FINE SANDY LOAM*

This soil has an area of less than a square mile. It is found chiefly in Palmyra and Sumner Townships, where it is associated with areas of the other Clyde soils and Peat.

Clyde fine sandy loam consists of 12 inches of black fine sandy loam, containing a relatively large quantity of organic matter, underlain by a brown fine sandy loam to a depth of 20 inches and then with yellow fine sand to a depth of more than 3 feet.

The surface of the type is flat and the natural drainage deficient. It has the same origin and supports the same character of forest as the Clyde sandy loam.

About 10 per cent of the type is under cultivation, the remainder being in pasture or hay lots. Where cultivated, it is devoted to general farm crops, chiefly corn, which yields about 30 bushels per acre. Some oats are grown, yielding from 30 to 40 bushels per acre. When drained, the type is easy to cultivate and can be worked under quite a wide range of moisture conditions.

CLYDE SANDY LOAM

Clyde sandy loam is of very small extent. It is found chiefly due north of Oak Hill, in Sullivan Township. Here it occurs between areas of Peat and areas of Miami soils.

The surface soil of Clyde sandy loam consists of about 10 inches of black, loose, open, medium sandy loam, with a high organic-matter content. The subsoil consists of a grayish medium sandy loam, frequently mottled with yellow iron stains. Streaks or thin beds of sandy clay are very common in the subsoil. Around the borders of some of the Peat marshes the type occurs with considerable Peat or Muck mixed with the surface soil. In such places the subsoil is usually a gray medium sand to 36 inches, where sandy clay is reached. The surface of the type is flat and the natural drainage poor.

* For chemical composition and improvement of this type see page 55.

The soil is derived from glacial material deposited in the beds of old lakes, though it may be in part colluvial or alluvial.

Only a small part of the type is cultivated. Conditions of cropping are very much as on the fine sandy loam.

CHEMICAL COMPOSITION AND IMPROVEMENT OF THE DARK COLORED, POORLY DRAINED SOILS

The soils of this group make up 25 per cent of the total area of the county, and their improvement is therefore an important item, as at the present time only a small acreage of these types are under cultivation.

These types of soil are characterized by having relatively large amounts of organic matter, accumulated as a result of poor drainage. As is usually the case, accumulation of organic matter increases the total content of phosphorus, but this does not necessarily mean that this element is readily available. Its availability will depend largely on the rate of decomposition of the vegetable matter.

The total amount of phosphorus in the heavy members of this group will run in excess of 2000 pounds per acre in the surface 8 inches, while in the sandy members the amount averages about 1000 pounds.

It is frequently true that soils of these types are well supplied with available phosphorus for a few years after being reclaimed but it must always be borne in mind that such soils are likely to show a deficiency in the available supplies of this element after a period of cropping unless barnyard manure or other fertilizer is used. The total amount of potassium in these soils is fair in all cases and large in some, but the chief question with reference to this element is not the total amount present, but conditions affecting its availability. While soils well supplied with vegetable matter as these usually are do not need special treatment with reference to potassium immediately after reclamation, they very generally do show a need of care in this regard within a few years, and patches of these types frequently fail to produce satisfactory crops even immediately after drainage and breaking unless barnyard manure or special potash fertilizer is supplied.

Owing to the fact that these soils receive the drainage from higher surrounding land the subsoil of which contains large amounts of lime, they are as a rule well supplied with this substance and are not acid. Their lack of sufficient drainage limits their use for the growth of alfalfa or medium red clover to which otherwise they would be well adapted. These soils are, of course, usually well sup-

plied with nitrogen—indeed they contain on an average from 3 to 5 times as much of this element as do the upland light colored silt and clay loam soils of this region. They do not therefore need special care with reference to this element and it is frequently more economical to use commercial fertilizers containing potassium and also phosphorus, where these elements are needed on such soils, and permitting the use of all the manure of the farm on the upland light colored soils which require nitrogen as well as the other elements.

In the improvement of these types the first question which should be given consideration is that of drainage.* Only a small proportion of the total area of this group is sufficiently drained. On the heavy types, plowing fields in narrow strips with dead furrows from to 2 4 rods apart, and having these lead into open ditches along the side of the field will greatly assist in carrying off the surface water. In order to make the internal drainage of the soil complete, however, tile drains should be used to supplement the surface drains. From tests made by tile draining such land it has been found that the increased crops will pay for the improvement in the course of a few years.

When the drainage of these soils has been established and the crop yields still seem to be deficient, the question of applying commercial fertilizers should be considered. Ground rock phosphate should be applied at the rate of about 600 pounds per acre for the first application and from 300 to 400 pounds per acre once during each succeeding rotation. Muriate of potash may be applied for general farm crops, at the rate of about 150 pounds per acre. If cabbage or beets are to be grown from 250 to 300 pounds per acre should be applied. When these crops are grown in rotation it may be necessary to use potash fertilizer in seeding down with a cereal crop following a crop on which a heavy application was used the previous year.

Rock phosphate may be applied at any time and should ordinarily be spread broadcast and either plowed in, disked, or harrowed in so as to have it well distributed through the soil. On account of the small bulk of the fertilizer used, it can be applied readily by hand, in seeding grain, or the potash and rock phosphate may be mixed and applied in the spring in one of the many fertilizer distributors on the market. Before using these commercial fertilizers over large tracts, however, it would be well to make tests on small plots to determine the need of the soil over any specific area, since there may be considerable variation due to drainage, the condition of the organic matter, etc.

* See Bulletin 339 Wisconsin Experiment Station—"The Right Drain for the Right Place".

Care must be exercised in the cultivation of the heavy soils, and they should be plowed only when the moisture conditions are the most favorable. Because of the large amount of organic matter present they are not as difficult to cultivate as light colored soils of the same texture.

When these soils are thoroughly drained alfalfa and the clovers may be grown successfully, and the acreage devoted to these crops should be increased. Such crops as cabbage and sugar beets can be grown successfully, but the heavy soils are too heavy for growing potatoes or the ordinary truck crops on a commercial scale. Such soils are best adapted to general farming and dairying, and these are the lines along which the greatest development is now being made.

CHAPTER VII.

MARSH SOILS.

PEAT

(With included areas of Muck)

Extent and distribution.—Peat (with included areas of Muck) is one of the most extensive soils in Jefferson County, being found in every township. The largest area lies southwest of Oak Hill, in Palmyra and Cold Spring Townships, along Scuppernong River. Other large tracts are found in Jefferson, Hebron, Sullivan, Concrod, Waterloo, and Lake Mills Townships.

Description.—The material mapped as Peat (with included areas of Muck) in Jefferson County consists of vegetable matter in varying stages of decomposition, to which has been added, in some cases, a small amount of mineral matter. Where the Peat is only partially decomposed, as is the case over most of the type, the material has a brown color and is very fibrous. Where a more advanced state of decomposition has been reached the fibrous structure has largely disappeared, and the material is black and has a smooth feel. Around the margin of the large marshes, and over a considerable proportion of many of the small ones, varying amounts of mineral matter have been washed down from the surrounding uplands and mixed with the Peat. While this is seldom sufficient to warrant the establishing of a Muck type, there are here and there a few areas of typical Muck. These were not separated, on account of their small extent. In the larger marshes the Peat soil extends to a depth of 5 to 15 feet; in the smaller ones the depth varies from 2 to 5 feet. The underlying material is usually a light-gray or bluish, plastic silty clay, which is generally mottled.

In sections 13, 14, 33, and 34, Sullivan Township, and in the areas in Palmyra Township which are associated with sandy upland types, the Peat is underlain by a light-gray sand of medium to fine texture or by a light mottled sandy clay. A shallow phase occurs in section 1, Concord Township, and in sections 4 and 9, Milford Township, and extending into section 3, Watertown Township; the surface here consists of 12 to 20 inches of black, mucky Peat. Considerable

mineral matter is mingled with the organic material, but it is hardly sufficient to warrant classing the soil as Muck. The soil is underlain usually by a light-gray mottled clay and in local spots by grayish sand. Deposits of marl occur under some of the Peat marshes.

Topography and drainage.—By far the greater proportion of the surface of the Peat is flat. There are, however, a number of places where the areas lie on gentle slopes or where the surface is gently undulating. The drainage of the Peat is naturally very defective, and only a small proportion of it can be farmed without first installing some sort of a drainage system.

Origin.—Peat owes its origin to the accumulation of organic matter resulting from the growth and decay of rank water-loving vegetation. Marsh grasses, sedges, and sphagnum moss have added much material, but the leaves, limbs, and roots of trees have also helped to build up the deposits.

Native vegetation.—About 15 to 20 per cent of the Peat is timbered with tamarack, and the remainder as covered with coarse marsh grass.

Present agricultural development.—Only a very few small areas of the Peat are under cultivation at present. The marsh grass yields large quantities of hay, which can be readily cut during dry seasons. In wet seasons, however, the ground is too soft to support a team. As a rule the marshes are cut into small tracts and owned by the farmers on the surrounding upland, who depend on the marshes for hay in dry seasons, when the upland crop is apt to be a failure. A few patches of corn were seen growing on the Peat, though most of this was where mineral matter had been washed in from the upland and mixed with the Peat. On some of the gentle slopes where the Peat was quite fibrous and only partially decomposed this crop was also grown.

CHEMICAL COMPOSITION AND IMPROVEMENT OF PEAT

Nineteen per cent of Jefferson County consists of Peat land, and only a very small proportion of it has been drained. Since most of this land can be drained and profitably farmed, its improvement is of great economic importance.

Peat has been largely formed by the accumulation of vegetable matter, particularly sphagnum moss and certain sedges and grasses. It is very low in earthly matter, running from 80 to 95 per cent of organic matter. The amount of the mineral elements is consequently low, the total weight of phosphorus being approximately 600 pounds per acre to a depth of 8 inches, and of potassium, 700 pounds. It

will be seen, on comparison of these statements with those made on the composition of such soils as Miami silt loam and Fox silt loam, that the total amount of potassum, in particular, is extremely small, the amount in Peat often being less than 2 per cent of that found in the upland silt loam soils. While the total amount is small, a large proportion of it is available to plants, especially if the surface has been burnt over, and the supply may be sufficient for from 1 to 3 crops. It is to be expected, therefore, that profitable cropping is possible over a long period of years, only by the use of some form of potassium fertilizer, either barnyard manure, wood ashes, or the usual commercial fertilizers containing this element. The total supply of phosphorus is rather low, though the difference between the amounts present in Peat and upland soils is very much less than in the case of potassium. In view of the enormous quantity of nitrogen contained in these soils, the average amount of which is over 15,000 pounds per acre 8 inches, it is unnecessary to use stable manure, the most valuable element of which is the nitrogen, so that, on farms including both Peat or Muck land and upland soils, the stable manure should be used on the upland, and commercial fertilizers containing phosphorus and potash, if needed, on the lower land, unless, indeed, there is sufficient manure for the entire farm, which is rarely the case. These marsh soils are rarely acid on account of the percolation of lime-containing water from higher lands, though occasionally patches of acid Peat are found on the larger marshes. This acidity, however, is not so detrimental in the case of marsh lands as in the case of sand and clay soils, since the chief objection to acidity is that it interferes with the growth of those legumes, such as clover and alfalfa, which are needed on the higher lands to secure nitrogen, but which are not needed on the marsh soils for this purpose, and to the growth of which, indeed, the marsh soils are not so well adapted physically.

In the improvement of Peat the question of drainage* is the first step to be considered. Both open ditches and tile drains can be utilized in reclaiming the marshy tracts. The major portion of the Peat areas in Jefferson county can be profitably drained and improved. When properly handled the Peat will produce profitable crops of corn, alsike clover, timothy, and a number of other general farm crops, as well as special crops such as peppermint, celery, etc.

* For special information concerning drainage, write the Soils Department of the Wisconsin Experiment Station.

CHAPTER VIII.

GENERAL AGRICULTURE OF JEFFERSON COUNTY.

The agriculture of Jefferson County dates back to about 1836, when the first settlement was made. The chief crops grown by the pioneers were wheat, corn, oats, and hay. Wheat early became the most important product of the farms and continued to be the cash crop for many years. There was a gradual increase in the acreage devoted to this crop until about 1862, when the invasion of the chinch bug did considerable damage to the crop and caused a reduction in the acreage. The decline in interest in wheat was only temporary, however, and in 1865 over a quarter of a million bushels were produced. In 1877 the crop amounted to 409,172 bushels. Since 1880 there has been a gradual reduction in the acreage, the census of 1910 reporting only 3,191 acres of wheat in Jefferson County. The average yield at that time was slightly over 20 bushels per acre.

Hops were grown very extensively in this county at one time. In 1860 the industry was in its infancy, but by 1868 it had assumed great proportions. In 1877 the yield was over half a million pounds. This rapid growth was due to the failure of the crop in the east and to the resulting high prices. Many of those who went into the industry first were very successful and it was not uncommon for a single crop to pay for the land and equipment. Nearly every farmer finally took up the production of this crop, and while the average acreage for each farm was about 4 or 5 acres, there were many fields of 10 to 15 acres. Large quantities of hops were also grown in other sections of the State and over-production resulted. Prices went so low that many failures followed and by 1885 the industry was entirely abandoned.

Corn was grown in the county as early as wheat, but was fed to the stock on the farms. By 1877 the yield of corn was greater than that of wheat and since that time it has remained the more important crop.

The raising of barley began about 1867 and reached its greatest proportions between 1880 and 1890. The average yields declined

about that time, owing chiefly to continued cropping on the same fields and to the use of inferior seed.

Oats were grown with corn and wheat in the early days, though to a smaller extent than the two latter crops. During later years, however, it has come to be more extensively grown than any other cereal crop in the county.

During the early history of the county the methods of cultivation were rather crude and but little, if any, attention was given to the rotation of crops, thorough tillage, the selection of seed, or the adaptation of crops to certain kinds of soil. Land was plentiful and wasteful methods were common. Continued cropping of fields to the same crop, together with inferior methods of cultivation, had a tendency to lower the productiveness of the lands. When the cause for the reduction in yields became apparent a gradual change took place in the agricultural practices followed and improved methods were introduced. The system of agriculture which is being followed at the present time is far in advance of the old methods.

Before the coming of the railroad the marketing of farm produce was difficult and expensive. Most of the grain was hauled by teams over plank roads to Milwaukee. The first plank road was built from Watertown to Milwaukee in 1836. A few years later one was completed from Milwaukee to Whitewater, which lies just outside of the county to the south. The coming of the railroads reduced these long hauls, opened up new markets, and did much to encourage the development of agriculture. The *Prairie du Chien* Division of the Chicago, Milwaukee & St. Paul Railroad was completed through the county in 1851, and the *La Cross* Division in 1855.

The chief type of agriculture followed at the present time consists of general farming in conjunction with dairying and stock raising. This system of farming is followed throughout the county, though in the southeastern corner in Oakland and Sumner Townships it is not as important as elsewhere, because in this region some tobacco is grown. Special lines of farming, such as trucking, fruit growing, etc., are developed only to a very small extent.

The general farm crops grown in the county; in order of the acreage devoted to each, are hay, oats, corn, barley, rye, wheat, potatoes, tobacco, peas, sugar beets, beans, and a few truck crops. The figures given below in connection with the various crops, etc., are taken from the censns of 1910 and give a fairly accurate idea of the relative importance of the agricultural products of the county.

The acreage of hay is greater than that of any other crop. From 67,189 acres a production of 112,058 tons, or about 1.7 tons per acre, was secured. Of this acreage 28,015 acres was wild hay grown in

marshes and other low, poorly drained areas. The average yield of such hay was 1.3 tons per acre. From 14,640 acres of timothy and clover mixed an average yield of 1.6 tons per acre was secured. Timothy was grown alone on 12,606 acres and gave an average yield of 1.6 tons per acre. Clover alone covered only 2,824 acres, with an average yield of 1.8 tons per acre. The acreage of alfalfa was 2,251 acres, with a yield of 2.2 tons per acre. Other kinds of hay grown to a small extent are oats and peas cut green and cured, alsike clover, and a small quantity of millet.

Clover and timothy are usually seeded with a nurse crop consisting of wheat, oats, barley, or rye. Some difficulty has been experienced in getting a good stand, especially on the lighter soils, which are usually in an acid condition and contain only a small amount of organic matter. The hot, dry weather of late summer frequently kills some of the clover and the period immediately following the removal of the nurse crop is also a critical stage in the growth of the clover plant. Clover does better on the Miami silt loam and loam and Fox silt loam types than on the other soils of the county. The Miami gravelly sandy loam also produced good clover. Clover seed is produced to a considerable extent, especially in the vicinity of Waterloo. Some alsike clover is grown, especially on the more poorly drained types, such as the Clyde silt loam. It does better under such conditions than any of the other legumes. Yields of $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre are secured.

Alfalfa has become an important crop in the county. On a considerable number of dairy farms it is considered the most important crop that can be produced, since it yields a larger amount of valuable feed per acre than any other crop adapted to this region. While the average yield given by the census for 1910 is but 2.2 tons per acre, returns much larger than this are secured when the crop is properly handled. Yields of 4 tons per acre are quite common and 6 tons per acre have been secured on the most highly improved farms. The possibilities of this crop for Jefferson County are thus shown to be very great.

Alfalfa is grown most extensively on the Miami silt loam, Miami gravelly sandy loam, and Fox silt loam. About 20 pounds of seed per acre is the amount sown.

There is a larger acreage devoted to oats than to any other grain crop in the county. From 45,469 acres in 1909 the total production was 1,688,972 bushels, or an average of approximately 37 bushels per acre. Sweedish Select is probably the most common variety grown. In some portions of the county pure-bred oats are being raised for the seed market. A part of the crop is sold. Oats are most exten-

sively grown on the Miami silt loam, loam, gravelly sandy loam, fine sandy loam, and Fox silt loam. On the Clyde soils the growth of straw is apt to be too heavy and the crop is likely to lodge. The quality of the grain is also inferior to that grown on the light-colored upland soils.

The acreage of corn is nearly equal to that of oats and it is one of the leading crops of the county. From 40,250 acres a total production of 1,516,137 bushels was secured, or an average of approximately 37 bushels per acre. A large proportion of the crop is used as ensilage. Large quantities of corn are fed to hogs and much is also ground to form a portion of the grain ration for dairy cows. The stalks are often shredded in the fall and stored in the barn, or they may be left in the field in the shock and hauled to the feeding lot as needed during the winter. Leaming and Eureka are two varieties grown to a considerable extent for silage. Wisconsin Nos. 7, 8, and 12 are improved early maturing dent varieties which are gradually coming into more common use. The majority of farmers, however, plant unimproved seed. Corn is grown on practically all of the soils of the county, though well-drained areas of the Clyde silt loam and clay loam are probably best adapted to its culture. It does very well on the Miami silt loam, loam, and Fox silt loam.

Barley, though increasing in favor, is not grown as extensively at present as it was 25 years ago. In 1909 the crop from 10,940 acres amounted to 317,253 bushels, or an average of approximately 28 bushels per acre. The variety most commonly grown is the Oderbrucker. Careful breeding and seed selection have improved the yields and also the quality of the grain. Most of the barley is produced in the northern part of the county on the Miami silt loam and Miami loam.

Rye is grown only to a limited extent and is confined largely to the lighter soils of the county. The crop of 1909 from 3,326 acres amounted to 53,387 bushels, or an average of about 16 bushels per acre. Some of the rye is ground and fed to hogs, a little is used making rye flour for bread, but the greater part of the crop is sold.

The acreage of wheat is even smaller than that of rye. From 3,191 acres the production of 1909 was 62,807 bushels, or an average of approximately 19 bushels per acre. It is grown chiefly on the Miami silt loam and Miami loam types.

Irish potatoes are next in acreage to wheat and the crop of 1909 from 1,771 acres amounted to 193,395 bushels, or approximately 109 bushels per acre. The crop is not grown on a commercial scale except in a very small way, though nearly every farmer produces enough for home use and frequently has some to place upon the

market. The fine sandy loam types are better adapted to potatoes than the heavier soils of the county.

The growing of tobacco is almost entirely confined to the two western tiers of sections of Oakland and Sumner Townships in the southwestern corner of the county. This strip of country forms an intermediate belt between the great tobacco section of Dane County on the west and the dairy country to the east. Tobacco was first introduced into the State about 1858 and at one time was an important crop in this county. It has given way largely to the dairy industry and the acreage in 1909 was only 455 acres, from which the average yield was 1,174 pounds per acre. The acreage is being still further reduced. Tobacco growing is confined largely to the Norwegian settlement. The fields are fertilized very heavily with stable manure and as a rule the productiveness of the farm as a whole is sacrificed for the tobacco patch.

The growing of peas for canning is carried on to a small extent. There is a factory at Waterloo, one at Fort Atkinson, and one at Watertown. There are several viners tributary to the factory at Fort Atkinson. The vines are for the most part preserved in the silo at the viners and the pea silage returned to the farmers and fed to the stock before the corn crop is cut. The crop is planted at intervals so that the harvest may spread over a considerable period of time and permit cutting the entire crop when the peas are in the proper stage. The size of pea fields ranges from 5 to 15 acres and the gross receipts from \$30 to \$90 per acre. The average gross returns for 1912 were about \$49 an acre.

Peas of the best quality are produced on the Miami silt loam, and by far the greater proportion of the crop is grown on this type. Peas are grown to maturity to a considerable extent in parts of the county. Seed men at Waterloo contract for from 16,000 to 20,000 bushels of seed peas yearly at about \$2 a bushel. A portion of these are grown in the adjoining counties of Dane and Dodge. Among the varieties of peas grown in Jefferson County are Alaska, Hørsford, Market Garden, and Advance. The rotation most commonly followed consists of one year each of peas, corn, and oats, followed by one or two years of clover. The rotation recommended by the factory at Waterloo is one year each of peas, clover, and corn.

In the vicinity of Fort Atkinson sweet corn is grown for canning by the same factory that handles the peas. Several hundred acres are devoted to this crop. The price for 1912 was \$8 a ton for snapped ears. The small ears are left on the stalks and either cut and put into the silo or allowed to cure in the shock. The average returns from the snapped ears amounts to about \$35 an acre. Most of this

corn is grown on the Miami fine sandy loam. The Miami silt loam produces good sweet corn, but there are no extensive tracts of this soil close to the factory.

Sugar beets are grown in the county only to a very small extent. They are produced chiefly on the Miami silt loam, though a few are grown on the Miami fine sandy loam. The industry has not been extended to the Clyde soils in this county. The light-colored upland types produce beets with a higher sugar content, but the tonnage is usually considerably greater on the well-drained Clyde soils. Most of the beets are shipped to the factory at Janesville.

Beans, buckwheat, sorghum, emmer, and spelt are crops of minor importance in the county.

The trucking industry has not been developed to any extent. Cucumbers are grown in the vicinity of Palmyra and some melons in various parts of the county. Every farm has its garden where all sorts of vegetables are grown for home use, but the market garden has not been developed in this region.

Fruit growing has not been developed on a commercial scale, though on many of the farms there are small orchards of apples, cherries, pears, and plums that supply chiefly the home needs. During favorable seasons a few apples may be sold, since the apple trees are the most numerous. Of the small fruits strawberries, currants, gooseberries, blackberries, and raspberries are grown in small patches, chiefly for home use, though a few are sold in the towns within the county.

Dairying is the most important branch of farming in Jefferson County. In 1913 there were 46 creameries, 9 cheese factories, 5 skimming stations, and 4 condenseries within its limits. The amount of butter produced in 1909 amounted to approximately 5,500,000 pounds, while there was a little over a half million pounds of cheese made. The dairy industry requires the production of a large quantity of hay and corn. In 1909, 18.5 per cent of the improved land in the county was in corn and 30.8 per cent was in hay. For every 100 acres of hay and corn combined there were 26.5 milch cows. For every 100 head of cattle in the county there were 62.6 milch cows.

When the creameries pay for the amount of butter fat the price of cream is usually about 2 cents above Elgin prices, the overrun being kept by the creamery for making the butter. When the actual amount of butter is paid for the price is the Elgin quotation minus two-thirds cent per pound for making the butter. When the milk or cream is hauled by the creamery 10 to 15 cents per hundred-weight is charged for such service.

The cheese factories have a considerable range in the price paid for milk. In the summer the price goes as low as 85 cents per hundredweight, and this is increased to about \$1.70 during the winter. Brick cheese is the kind most commonly made, though other kinds are also produced. The farmers return the whey to the farm and feed it to the pigs.

When milk is sold to the condenseries the price varies from about \$1.40 in summer to \$1.70 in winter. The test is not taken into consideration, but if it falls below 3 per cent the milk is rejected. Considerable whole milk is shipped from the county, chiefly to Milwaukee. The Chicago, Milwaukee & St. Paul Railroad runs a milk train from Waterloo to Milwaukee and also one from Janesville to Milwaukee. A car is sent from Palmyra every day. Considerable milk is also collected along the lines of the Chicago & North Western Railroad. The milk is shipped in 8-gallon cans, and the annual average price paid for milk delivered in Milwaukee is about \$1.10 per can.

Doubtless the majority of the cattle in the county are of grade stock, though there are probably as many pure breds as in any other county of equal size in the State. It has been estimated that between 80 and 90 per cent of the cattle show some Holstein blood, and there are more pure-bred Holsteins than any other breed. The Guernseys are the second breed of importance from the standpoint of numbers, and stock of excellent quality is being raised. It is considered by many farmers that the Holstein is a more economical producer than any of the other breeds. The Holstein will handle a large amount of roughage and give a large amount of milk, but the milk tests considerably lower than the Guernsey. The calves are large and if it is desired to veal them their good size will insure larger returns than if smaller breeds are used. The Guernsey milk has a rich yellow color, a high butter-fat content, and is often preferred by many people who buy milk. The number of Guernsey cattle is gradually increasing. Guernsey and Holstein breeders' associations have been organized in the county and are doing much to advance the interest of these breeds. Through these organizations much pure-bred stock and also considerable good grade stock is sold to buyers from various parts of this country. Stock has been shipped from here to Mexico, Japan, New Zealand, and other foreign countries.

The conditions in Jefferson County are very favorable for dairying and the average farmer engaged in the business keeps from 15 to 18 cows. Many who make a specialty of it keep from 25 to 30 cows. The silo is in common use; probably over half of the farmers keeping

dairy cows have one. The stave silo is the prevailing type, though cement, brick, and tile are also used in their construction. More are being built each year.

Very few beef cattle are raised in the county, though on a number of farms a few steers are fed each year. Most of the male calves of grade stock from the dairy farms are vealed. The majority of the cattle sold for beef are old milch cows which are no longer profitable milk producers, or animals which do not give promise of becoming profitable producers. In 1909, 24,039 calves were sold or slaughtered in Jefferson County.

Sheep are not raised to any extent in the county, the total number in 1910 being 4,938.

Hogs are raised to a considerable extent in conjunction with dairying, the census of 1910 showing 43,650 in the county. The chief breeds represented are Poland China, Berkshire, Duroc Jersey, and Chester White. A sausage factory at Fort Atkinson uses about 12,000 hogs each year and the packing house at Jefferson also uses quite a number. Milwaukee and Chicago are the outside markets for hogs and other live stock.

Horses are not raised very extensively, but most of the farmers raise one or two colts nearly every year and frequently have a team to sell. The sires used are mostly Percheron and the quality of the work stock is gradually being improved. According to the census of 1910 there were 12,162 horses in the county.

The poultry industry has been developed to a considerable extent on many of the farms. Chickens are more numerous than other fowls and in 1909 the production of eggs was 1,435,396 dozen. Turkeys, ducks, and geese are also raised. Geese from the vicinity of Watertown have a national reputation for quality.

The question of the adaptation of crops to certain soils has been given some consideration, and it is recognized that corn, for example, gives better yields as a general rule on well-drained areas of Clyde silt loam or Clyde clay loam than on the light-colored upland soils of various textures. On the other hand, oats and barley of better quality are produced on the light-colored upland soils than on the black, low-lying types. Potatoes do better on the sandy loam types than on the heavy soils of the county. The important question of soil adaptation, however, has not been carefully studied and there is opportunity for experimentation along this line.

In the crop rotations practiced there is considerable variation, due to differences in texture of the soil, drainage conditions, and the types of farming followed. Probably the most common rotation consists of one year corn, one year oats, and two years clover and

timothy. Oats may be grown for two years or barley or rye may be grown one year in addition to the oats. Rye is mostly grown on the lighter types. Where there is no lowland on the farm, which is seldom the case, one year of pasture may follow the cutting of hay. On farms where alfalfa is the chief hay crop the rotation consists of corn one year, oats or barley one year, or both of these crops for one year each, followed by three to five years of alfalfa. Where tobacco is grown the rotation may be one year each of corn and oats or barley, two years clover and timothy, and two to four years of tobacco. The rotation which appears to have given the best results and the one advanced by the most up-to-date farmers consists of corn for two years, oats or barley for one year, and alfalfa for three or four years.

There is considerable variation in the methods of cultivation, as well as in the rotations followed. It is considered desirable to plow sod land in the fall, especially on the heavier soils, and when time will permit stubble land may also be plowed in the fall. Weather conditions and delay in farm work, however, often prevent much of this work in the fall. It is customary to apply manure to sod land which is to be plowed for corn. If the land is plowed in the fall the manure is often hauled out during the winter and scattered over the plowed surface. If the field is not plowed in the fall the manure is plowed under in the spring. When stubble land is plowed in the late summer manure is frequently applied before plowing. Where tobacco is grown practically all of the manure is applied to the tobacco field.

Among the weed pests most troublesome in the county may be mentioned the wild mustard, quack grass, white daisy, and Canada thistle. While none of these are plentiful enough to cause alarm, they should nevertheless be kept down, and efforts made to eradicate them, for unless checked they will spread rapidly and become a great source of annoyance as well as the direct cause of reduction in the yields of various field crops.

The general appearance of the farmsteads throughout the survey is one of thrift and prosperity. As a rule the farm buildings are substantial, painted, and in good repair. Fields are securely fenced, well cultivated, and modern labor-saving machinery is in common use.

On a great many of the farms in the county all of the labor is done by the family. Where hired help is necessary the wages range from \$25 to \$28 a month for about nine months. This includes board, washing, and usually the keeping of one horse. Where no horse is kept the wages may range from \$30 to \$35 a month. On

many of the dairy farms the help is retained for the entire year, and the salary then ranges from \$300 to \$500 a year.

Of all the land in the county, 94.9 per cent is in farms, and of this 64.9 per cent is improved. There are 3,356 farms the average size of which is 100 acres. On the average there are 65 acres of improved land on every farm. Of all farms 79.9 per cent are operated by the owner. Where land is rented the share system and cash rental are about equally represented. The average value of land in the county in 1910 was \$65.18 an acre, which is an increase of 35.8 per cent over the value in 1900. Of the total value of all farm property, 63.3 per cent is represented by the land, 22.1 per cent by the buildings, 3.6 per cent by implements and machinery, and 11 per cent by farm animals, including poultry, etc.

While the methods of farming followed, the crops grown, and the types of agriculture practiced are fairly well adapted to present conditions, there are nevertheless a number of lines along which improvement could well be made.

As natural conditions in the county are well suited to dairying, this industry, which is already very important, could well be extended to greater proportions. Some of the soil types will respond very well to applications of rock phosphate. Erosion should be prevented wherever possible and the methods of cropping and cultivation should be altered where necessary to keep the steep portions of fields from washing.

The trucking industry could be extended with profit, especially on the sandy soils of the county. The orchard should be given attention and every farm should have enough of the different kinds of fruit to supply the home. The drainage of low-lying land in the county, including the Peat marshes, would add greatly to the tillable area of productive soils. Many of these tracts could be readily drained at comparatively small cost and when properly managed would prove very profitable.

CHAPTER IX.

CLIMATE.*

"Among the factors which influence the agriculture of a state none is more important than climate. The class of crops which can be grown is largely determined by the length of the growing season, and the amount and distribution of the rainfall." Any one of these factors may determine the type of farming which can be followed to best advantage.

"The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation having a range of from 28 to 34 inches, while the mean for the state as a whole is 31 inches. This is a slightly heavier rainfall than is received by eastern England, northern France, most of Germany, and Sweden. As compared with other portions of this country, Wisconsin has a total rainfall equaling that of central Oklahoma and Kansas, northern Iowa, Michigan, Northwestern New York, or the Puget Sound Basin of Washington. But owing to its northerly location, the lessened evaporation probably makes the precipitation as effective as that of Arkansas, Illinois, or Virginia."

The local distribution of rainfall varies, however, from year to year, some sections receiving more rain one year, and other sections more in other years. The variation is caused largely by the movement of cyclonic storms. The average rainfall for the entire state during the driest year was 21.4 inches, and for the wettest year 37 inches.

"Of equal importance, in agriculture, to the total rainfall, is its seasonal distribution, and in this respect Wisconsin is unusually fortunate, since about half of the total rainfall comes in May, June, July, and August, and nearly 70% from April to September, inclusive. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches and May 3.9 inches. The precipitation during the winter, on the other hand, is slight; December, January, and February each averaging from 1 to 1.5 inches of rain and melted snow. The average rainfall for the state during winter is 3.9 inches, during spring 8.3 inches, during summer 11.4 inches and during

* This chapter has been taken largely from Wisconsin Bulletin 223 on The Climate of Wisconsin and its Relation to Agriculture. This bulletin should be consulted if more information is desired concerning climate. All quotations indicated are taken from this bulletin.

autumn 7.4 inches. Most of the rainfall occurs just preceding and during the period of plant growth, thus being received by the crop at the most effective time. Wisconsin receives during the growing season, April to September, inclusive, an average of 21 inches of precipitation, which is as much rain as that received during the same months by eastern Texas, Illinois, Ohio, or eastern New York. The small winter precipitation in Wisconsin, mostly in the form of snow, on the other hand, causes virtually no leaching of fertility from the soil, or erosion."

Another phase of rainfall distribution of great importance is its variation within a period of a few weeks. Frequently periods of drought and periods of unusually heavy rainfall occur, continuing for one to four weeks and occasionally longer. Observations taken at Madison by the Weather Bureau over a period of 30 years from 1882 to 1911, inclusive, show that there are on the average three ten day periods during each growing season when the amount of rainfall is so slight that crops on a reasonably heavy soil (Miami silt loam) actually suffer from the lack of moisture. In Jefferson County the conditions are practically the same.

The following table gives the records of the United States Weather Bureau station located at Lake Mills, Jefferson County, the observations covering a period of 19 years. The station has an elevation above sea level of 897 feet. The date may be considered as fairly representative for the county.

Normal, monthly, seasonal, and annual temperature and precipitation at Lake Mills.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.
	<i>F.</i>	<i>F.</i>	<i>F.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
December.....	22.6	55	-19	1.73	1.21	1.67
January.....	18.4	57	-27	1.55	1.09	1.08
February.....	18.8	59	-24	1.25	.88	1.46
Winter.....	19.9			4.53	3.18	4.21
March.....	32.1	78	-4	2.18	2.75	2.07
April.....	45.7	87	14	3.06	.71	2.40
May.....	57.0	90	24	4.15	2.96	6.98
Spring.....	44.9			9.39	6.42	11.45
June.....	66.6	99	32	4.14	1.75	5.66
July.....	71.2	107	41	4.09	1.37	5.53
August.....	69.2	99	41	3.54	1.02	5.33
Summer.....	69.0			11.77	4.14	16.52
September.....	62.4	96	24	3.19	3.49	3.02
October.....	49.7	90	10	2.17	2.77	4.34
November.....	34.7	69	-3	2.11	.78	3.06
Fall.....	48.9			7.47	7.04	10.42
Year.....	45.7	107	-27	33.16	20.78	42.60

It will be seen from this table that the mean annual precipitation is 33.16 inches and that the greater proportion of this is normally distributed throughout the growing season, when most needed. During the months of April, May, June, July, August, and September there is over 3 inches each month, and during May, June, July, and August there is a normal rainfall of over 3.5 inches. The period of greatest variation in the rainfall is during June, July, and August. The normal for this period is 11.77 inches, while the amount during the driest year was 4.14 inches and the amount during the wettest year was 16.52 inches. Extremes of this nature seldom occur, but it is quite common to have a dry spell in July or August, or for a part of both months, during which crops suffer from lack of moisture. On account of the uneven topography over a portion of the county and the large amount of gravel and sand in the subsoil, some of the types are naturally droughty, and during dry seasons crops on such soils suffer.

The average snowfall is 32.9 inches, and under normal conditions crops of winter wheat, rye, clover, and alfalfa are well protected by a covering of snow. When the snowfall is light and the surface of the ground is exposed such crops are frequently damaged by freezing and thawing.

The lowest temperature recorded is -27° F. and the highest 107° F., with a mean annual temperature of 45.7° F. Such extremes, however, are infrequent and of short duration. The records at Lake Mills indicate that the average date of the first killing frost in the fall is October 15, and the last in the spring, April 23, with the earliest recorded in the fall, September 20, and the latest in the spring, June 12. This gives a growing season of 175 days. The records at Watertown, Jefferson County, which is but 14 miles northeast of Lake Mills, indicate that the growing season has a length of 168 days. In this connection the following is extracted from Bulletin 223 of the Wisconsin Agricultural Experiment Station on "The Climate of Wisconsin and its Relation to Agriculture." The bulletin divides Wisconsin into 8 climatic divisions and Jefferson County is included in what is called "The Rock River Basin." "This section has the longest growing season in the State, averaging about 170 days, which is as long as that of central Illinois, longer than central Indiana or Ohio, and about equal to the valley of Virginia and central Maryland. The annual temperature curves also show here a northward bend and though the winters (20°) are cooler than along the lake, the spring (45°) and summers (70°) are warmer. Hence this section is the best corn area in the State. The temperature of the Rock River Basin in summer is similar to that of northern

Illinois, Indiana, Ohio, and southeastern Pennsylvania, while in winter it resembles southern Vermont, northern Iowa, or southern Montana. During seven summer days, on the average, the thermometer may go as high as 90° and during five winter mornings fall to 10° below or lower."

Figures 2 and 3 show the average dates of the last killing frosts in the spring, and the first killing frosts in the fall. From the data given on these two maps the approximate length of growing season for any portion of the State may be readily determined.

The prevailing winds during the winter are from the west and north and during the summer from the west and south. This region is seldom visited by storms of a destructive character, though high winds are quite common during March. The climate is healthful, and especially delightful during the summer months. The water supply is abundant and of very good quality.

SUMMARY

Jefferson County is located in the southeastern part of Wisconsin and comprises an area of 570 square miles, or 364,800 acres. It lies within the glaciated limestone region and the surface varies from level to rolling and hilly. Peat marshes and other low-lying, poorly drained tracts are numerous. The upland section of the county is well settled, highly improved, and forms a part of the most highly developed agricultural region of Wisconsin.

The area is well supplied with transportation facilities and no point in the county is over 7 miles from a railroad.

The soils of the county are all of glacial or hydroglacial origin. They have been classified into 7 series including 23 soil types and several phases. In addition extensive areas of Peat (with included areas of Muck) have been mapped.

The Miami soils form the most important agricultural sections of the county. They consist of light-colored glacial material with which limestone is associated. The silt loam, loam, and fine sandy loam types are extensive and form good general farming soils. The gravelly sandy loam and fine sand are types of small extent.

The Fox series is of smaller extent and of less importance than the Miami. It includes the light-colored material occupying overwash plains, terraces, and filled-in valleys within the limestone region. The types mapped are the silt loam, loam, and fine sandy loam.

The Plainfield series includes light colored material occupying overwash plains, or stream terraces where there is no limestone present, or only such a small amount as to have no appreciable influence on the agricultural value of the soil. It differs from the Fox series in this one respect. The types mapped are Plainfield sand and fine sand.

The Rodman series includes light-colored assorted glacial material, chiefly in the form of kames and eskers. The soils are inextensive and have a low agriculture value. The types mapped were the gravelly sandy loam, fine sandy loam, fine sand, and gravel.

The Carrington series includes the dark-colored prairie soils in the glaciated limestone region. The series is of very small extent in this survey, though it is extensively developed in bordering counties. The silt loam, loam, and fine sandy loam were recognized.

The Waukesha series includes dark-colored outwash material and is represented by but one type, the loam, which is of very limited extent.

The Clyde series occupies old lake beds and poorly drained depressions and is characterized by a dark color and a high content of organic matter, though not sufficient to form Peat or Muck. When drained the soils make very productive land. The clay loam, silt loam, loam, sandy loam, and fine sandy loam were mapped.

Peat (with included areas of Muck) is composed of vegetable matter in varying stages of decomposition which has accumulated in old lake beds and poorly drained areas. Very large areas occur in this county, though the type has not been improved to any extent. When drained it can be made to yield profitable returns.

The type of agriculture consists of general farming in conjunction with dairying, which is highly developed in the county. The crops grown are hay, oats, corn, alfalfa, barley, rye, with some wheat, buckwheat, potatoes, sugar beets, peas, sweet corn, sorghum, melons, and cucumbers. The fruit industry is not developed on a commercial scale, though there are numerous small orchards which supply the home. Hogs are raised quite extensively in conjunction with dairying, but the raising of beef cattle and sheep is not given very much attention.

Crop rotations differ somewhat in various parts of the county, depending upon the character of the soil, drainage conditions, and the type of farming followed. In general it may be said that the rotations followed and the methods of cultivation practiced are fairly well adapted to present conditions.

Of all of the land in the survey 94.9 per cent is in farms, and of this 64.9 per cent is improved. There are 3,356 farms in the county with an average size of 100 acres. Of all farms 79.9 per cent are operated by the owners.

The mean annual precipitation is 33.16 inches and the mean temperature 45.7°. The length of the growing season ranges from 165 to 175 days, and all crops common to Wisconsin can be grown successfully. There is an average snowfall of 32.9 inches, forming protection for such crops as rye, wheat, clover, and alfalfa during the winter months, when the weather is severe. There is an abundant supply of good water in all parts of the county.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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SOIL SURVEY IN COOPERATION WITH THE COLLEGE OF AGRICULTURE

H. L. RUSSELL, Dean

BULLETIN NO. XLIX.

SOIL SERIES NO. 14

SOIL SURVEY
OF
COLUMBIA COUNTY
WISCONSIN

BY
A. R. WHITSON, W. J. GEIB, AND GUY W. CONREY
OF THE
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY
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SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES
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Soil Map of Columbia County, Wis.....	<i>Attached to back cover</i>
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INTRODUCTION

Before the greatest success in agriculture can be reached, it is necessary that the farmer should have a thorough knowledge of the soil upon his own farm. A soil may be well adapted to one crop, and poorly adapted to another crop. Clover will produce a vigorous growth and profitable yields on the average loam soil which contains lime and is in a sweet condition; but on a sandy soil which is sour, or in an acid condition, clover will not make a satisfactory growth. We may say, therefore, that failure is certain to be invited when such important facts are disregarded, or overlooked. The degree of success which it is possible to win on any farm is in direct proportion to the practical knowledge possessed by the farmer concerning the soil and its adaptation to crops. A thorough knowledge of the soil is as essential to the farmer as a knowledge of merchandise and business methods is to the merchant.

The State of Wisconsin working in cooperation with the United States Department of Agriculture, is making a careful study of soils and agricultural conditions throughout Wisconsin, and is preparing soil maps and soil reports of all counties in the State. A soil map shows the location and extent of the different kinds of soil. Tracts of 10 acres and over are mapped, but often areas of even smaller extent are shown. The soil map is prepared by trained men, who go over a county thoroughly, and examine the soil by making a sufficient number of borings to a depth of 36 inches to keep account of all variations. A report is also made to accompany and explain the map, and this is based upon a careful study of the soils within the region surveyed, and upon such other features as have a direct bearing upon the agriculture of the area.

It is the object of this survey to make an inventory of the soils of the state, and to be of practical help to farmers by locating and describing the different soils, by determining their physical character and chemical composition, and by offering suggestions for their management, based upon the work of the Soil Survey within the

area, covered in the report, and upon the results of field tests made by the Experiment Station.

Soil fertility depends upon two factors; first, upon the physical characteristics of the soil, such as water holding capacity, work ability, etc., and second, upon the chemical composition of the material composing the soil. The chemical composition depends upon the mode of origin of the soil, and the source of material from which the soil is derived.

Water holding capacity, and other physical properties of soil all depend chiefly upon *texture*, which refers to the size of the individual soil grains, or particles. A coarse sandy soil, for example, will not retain moisture so long as a loam soil, or clay loam, because the finer the soil grains, the greater will be the total soil-grain surface area to which moisture may adhere. Texture is determined in the field by rubbing the soil between the thumb and fingers, and with experience one soon becomes expert at judging the size of soil grains. This field judgment is verified in the laboratory by a *mechanical analysis*, which is made by a simple method of separating soil grains into different groups, of which there are seven. These are known as clay, silt, very fine sand, fine sand, medium sand, coarse sand and fine gravel.

A chemical analysis is also made of the soil to determine the amounts of various essential plant-food elements which are present. A chemical analysis shows whether the soil contains a large store of plant food, or only a small quantity, and it indicates which kinds of plant food will probably be needed first. The amount of organic matter in the soil is also determined, and tests are made to show conditions relative to soil acidity.

SOIL CLASSIFICATION

Soils are grouped according to texture into soil classes, a *soil class* being made up of soils having the same texture, though differing in other respects. A fine sand, for example, may be light colored and of alluvial origin, while another fine sand may be dark in color and of residual origin, while a third fine sand may have been blown into sand dunes by the wind, yet all of these soils would belong to the same class, because the greater proportion of the soil grains have the same size or texture. Thus we may have different kinds of clays, loams, sands, etc., and the class to which any soil will belong depends upon the size of the individual soil grains of which it is composed, and not upon its color, origin, topographic position, or agricultural value.

SOIL CLASSES

SOILS CONTAINING LESS THAN 20% SILT AND CLAY.

Coarse sand.—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.

Sand.—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.

Fine sand.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Very fine sand.—Over 50% very fine sand.

SOILS CONTAINING BETWEEN 20–50% OF SILT AND CLAY.

Sandy loam.—Over 25% fine gravel, coarse and medium sand.

Fine sandy loam.—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.

Sandy clay.—Less than 20% silt.

SOILS CONTAINING OVER 50% OF SILT AND CLAY.

Loam.—Less than 20% clay, and less than 50% silt.

Silt loam.—Less than 20% clay, and over 50% silt.

Clay loam.—Between 20 and 30% clay, and less than 50% silt.

Silty clay loam.—Between 20 and 30% clay, and over 50% silt.

Clay.—Over 30% clay.

Soils may be grouped in another way. Where soils are closely related through similar sources of the material from which derived, mode of origin, topographic position, etc., so that the dif-

ferent soils constitute merely a graduation in texture of otherwise uniform material, such a group is called a *soil series*. It corresponds to the family which is made up of different individuals having the same parentage. The Miami series, for example, includes light colored, glacial material where the soils have been derived largely from the underlying limestone, and the soils in the series range in texture from a clay loam to sand and gravel. The Plainfield series includes light colored soils in regions where no limestone is present, and where the material occurs as outwashed plains or stream terraces. The soils in this series also have a wide range in texture. The name used for a soil series usually indicates the locality where that particular series was first recognized and mapped by the Soil Survey.

By uniting the name of the *soil class*, which refers to texture, with the name of the *soil series*, which refers chiefly to origin, we get the *soil type*, which is the basis or unit of classifying and mapping soils. A *soil type*, thus, is a soil which is uniform throughout its entire extent in texture, color, topographic position, and other physical properties, and having a distinct agricultural unity, that is, being adapted to the same crops, and requiring the same treatment. It is also uniform in the source of material from which it is derived, and the mode of origin which, taken together, determine the chemical composition. Since the soil type is the unit in classifying and mapping soils, and the basis upon which experimental work should be conducted, every farmer should be familiar with the soil types on his farm, and their leading characteristics.

SOIL SURVEY OF COLUMBIA COUNTY, WISCONSIN

CHAPTER I

GENERAL DESCRIPTION OF THE AREA

Columbia County is located in the south-central part of Wisconsin. It is bounded on the north by Adams, Marquette, and Green Lake Counties, on the east by Dodge County, on the south by Dane County, and on the west by the Wisconsin River and Sauk County.

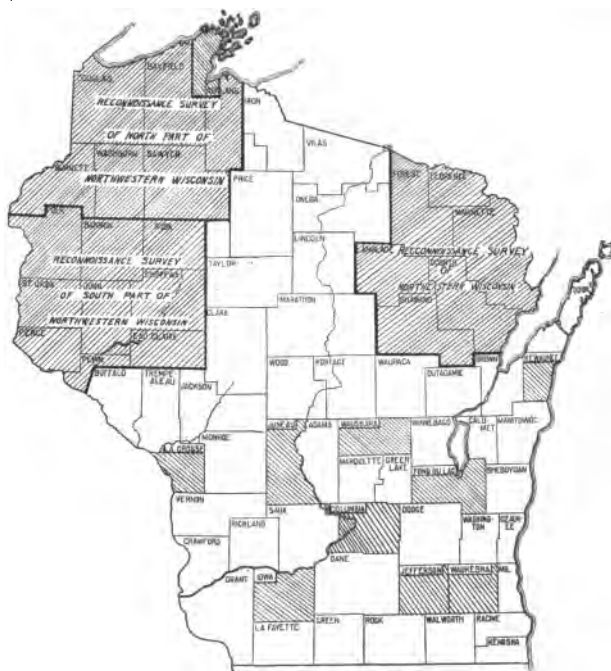


FIG. 1. Sketch map showing area surveyed.

The county has an extreme length east and west of about 39 miles and a width north and south of 25 miles. It embraces about 799 square miles, or 511,360 acres, some of which is of the finest agricultural land in the State.

The topography ranges from broad, level to undulating, black prairies rising from 200 to 300 feet above the Wisconsin River

to the rough and rugged hills of Caledonia Township, where the steep slopes are broken by ravines and numerous rock out-crops. An area intermediate between these two extremes comprises a region of some 70 square miles lying between Fall River and Randolph, and embraces a number of long, narrow, parallel ridges with intervening poorly drained areas of Peat and Muck.

The Wisconsin River flows through the western part of the county. In the northwestern corner its course is between steep sandstone cliffs from 30 to 100 feet high, frequently cut by tributary stream valleys. Below this point the river course continues through a broad flat valley until Dekorra is reached, beyond which point the valley then narrows, the steep slopes being dotted with outcrops of Potsdam sandstone. The remainder of the county is gently rolling to rolling, broken in some places by hills, with rock outcrops and marked in others by moraines, lakes, marshes, and many flat, poorly drained areas.

Columbia County is drained by three river systems, the Wisconsin, Fox, and Rock. The Empire Prairie, between Leeds and Arlington, which forms the watershed, continues northeast to the Portage Prairie, south of Cambria, where it swings to the east for several miles, crossing into Green Lake County, in a northerly direction about 2 miles from the corner of Columbia County. All of the territory east and south of this line drains into the Rock River system. North and west of this line the country drains into the Fox and Wisconsin Rivers.

The Fox and Wisconsin Rivers are separated by a drainage divide beginning in the high prairie north of Cambria and extending in a southwesterly direction to a point near Pardeeville, where it swings westward, continuing through Portage, and then northwest to a point about 2 miles south of Lewiston, leaving the county about 3 miles northeast of Kilbourn. The Wisconsin River and its tributaries drain about one-half of the county, the remainder being drained equally by the Fox and Rock Rivers. At Portage the Fox and Wisconsin Rivers are within 2 miles of each other. The water in the Wisconsin River is normally about 10 feet higher than in the Fox, a lock canal permitting boats to pass from one river to the other. During floods the Wisconsin River is with difficulty kept from cutting through the levees and pouring some of its waters into the Fox River.

Another interesting feature in the drainage of the county is that the numerous marshes, ponded valleys, lake beds, and lakes act as drainage basins for waters carried from the uplands by creeks and

gullies, the water from these low-lying areas being carried by sluggish streams to the larger streams and rivers.

White men first entered this region between 1670 and 1675. Marquette and Joliet ascended the Fox, crossed the "portage," and went down the Wisconsin in 1673. The first permanent settlement was made near Poynette in 1836. The county was organized in 1846, and Portage made the county seat in 1857. The population consists mostly of people of foreign extraction, including Germans, Norwegians, Welsh, Irish, Scotch, English and Dutch, and numbered 31,129 in 1910.

Portage, the county seat, is the largest city in the county, with a population of 5,440. It is an important railroad center and shipping point, with some manufacturing interests. Columbus, the second town in size, has a population of 2,523. A large canning factory is located here, and the city is in the center of a good farming country. Other towns and villages in the area are Kilbourn, Lodi, Randolph (partly in Dodge County), Cambria, Rio, Poynette, Wyocena, Pardeeville, Fall River, and Doylestown.

The county is well supplied with railroads, the main line of the Chicago, Milwaukee & St. Paul Railroad, between Chicago, Milwaukee, and Minneapolis, crossing it from southeast to northwest and passing through Columbus, Portage, Kilbourn, and intervening points. One branch of this line extends south from Portage to Madison through Poynette and Arlington, while another runs east through Pardeeville, Cambria, Randolph, and on to Beaver Dam and Horicon Junction, where it joins a branch extending to Milwaukee. The main line of the Chicago & North Western from Chicago to Minneapolis and St. Paul crosses the southwestern corner of the area, passing through Lodi. A new line direct from Milwaukee to the Twin Cities crosses the northeastern corner of the county. A branch of the Soo Line extends north from Portage to Grand Rapids and Stevens Point. It is 93 miles from Portage to Milwaukee and 178 miles to Chicago via the Chicago, Milwaukee & St. Paul. From Lodi to Chicago it is 158 miles via the Chicago & North Western.

The towns within the county furnish a market for considerable farm produce and offer excellent shipping facilities to more distant points. Most of the live stock and creamery products are shipped to Chicago, Milwaukee, or other outside points. Tobacco is usually sold at the local warehouses.

The wagon roads of the county are in good condition, except in the north-central part of the area, where the sand is quite deep. Considerable attention is now being paid to road improvement. The

school system is excellent, and the rural free delivery and telephone reach all parts of the county.

SOILS

The soils of Columbia County, Wisconsin, have been grouped into 10 soil series, comprising 29 types,* including Rough stony land, Muck, and Peat. Two of the types are residual and of minor importance, and with the exception of these and Muck and Peat all of the soils owe their origin to the weathering of glacial debris of the Late Wisconsin ice sheet. Much of this material has been influenced during and since its deposition by wind and water action and the accumulation of organic matter.

The underlying rock of the county has contributed very largely to the formation of the soils, much of the material carried by the ice sheet being deposited near-by. The eastern and southern parts of the county are underlain by limestone, the greater proportion of which is Lower Magnesian. In the extreme northeastern and southeastern corners of the county are small areas, over which the surface rock is the Trenton lime stone. Immediately beneath this and overlying the Lower Magnesian limestone is the St. Peters sandstone, which forms the surface rock over only a very small area about the margin of the Trenton. The central, northern, and most of the western parts of the county have the Potsdam sandstone as the surface rock, while west of the Wisconsin River in Caledonia Township a considerable tract of pre-Cambrian rocks, mostly quartzite, constitute the surface rock. These last-named rocks have contributed but slightly to the soils of the area, because of their hardness and the fact that they occur near the point where the ice sheet stopped. The action of the glacier was, therefore, not nearly as pronounced in this section as over other formations in the county. Some material foreign to this region, including stones and boulders of various kinds from the north, has also been brought in and mixed with the local glacial debris.

According to origin, the soils of Columbia County may be divided into eight general groups. The first includes the Miami fine sand, fine sandy loam, and loam, the Coloma fine sand, fine sandy loam, and the Carrington loam and fine sandy loam, all of which have been derived through weathering of the drift laid down by the late

*The Carrington silt loam as described in this report includes what was mapped and described in the Bureau of Soils' edition of the Columbia County report as Carrington silt loam, deep phase.

The Fox silt loam covered by this report includes what was described in the report of Bureau of Soils as Plainfield silt loam.

Wisconsin ice sheet. The Miami series comprises only the light-colored, timbered, glacial soils carrying a considerable amount of the parent limestone material. Gravel beds in the Miami regions frequently contain over 95 per cent of limestone gravel. The Coloma series includes light-colored, timbered glacial soils, carrying little or no limestone, and largely derived from the Potsdam sandstone. The Carrington series includes dark-colored, prairie, glacial soils.

The second general group includes the Miami silt loam, and Miami and Carrington silt loams which owe their origin chiefly to the weathering of a silty loesslike covering of the glacial till.

In the third group are the Plainfield fine sandy loam, fine sand, sand, and sandy loam, and the Genesee sand and fine sand. These types owe their origin to glacial drift stratified by running water. The Plainfield series includes light-colored and stratified, non-calcareous glacial material, occurring as overwash plains, terraces, or filled-in valleys, while the Genesee series is confined to the light-colored, water-laid material within the present flood plains of streams.

In the fourth group are found Fox silt loam, fine sandy loam and fine sand. This series includes light-colored water-laid material, occurring as overwash plains, terraces, or filled-in valleys. It differs from the Plainfield in being derived largely from limestone material.

The fifth group includes the Clyde silt loam, loam, fine sandy loam fine sand, Dunning loam and fine sandy loam and some Muck, all of which were formed from modified drift material with accumulations of organic matter. The Clyde series includes the black, low-lying calcareous soils of the glacial regions. The Dunning series is similar to the Clyde except that the material is non-calcareous and the soils are acid. These soils are high in organic matter. When the organic-matter content is high, but not sufficient to class the material as Peat, it is called Muck.

The sixth group contains the Peat derived almost entirely from the accumulation of partially decomposed vegetation.

The seventh group includes the Boone sand and the Rough stony land, both of which are largely residual soils, derived from the weathering and disintegrating of the Potsdam sandstone.

The eighth group includes the Knox silt loam. The series of this name embraces the light-colored silty soils, seemingly due to wind action. The silt loam is the only representative of this series in the county.

The following table gives the names and extent of each of the soils mapped in Columbia County:

Areas of Different Soils.

Soil	Acres	Per cent
Miami fine sandy soil.....	110,400	21.6
Miami silt loam.....	44,800	} 19.8
Miami silt loam, deep phase.....	56,320	
Carrington silt loam.....	70,464	13.8
Peat.....	51,264	10.0
Miami fine sand.....	43,584	8.5
Clyde silt loam.....	19,712	3.9
Plainfield fine sand.....	19,264	3.8
Carrington loam.....	11,840	2.3
Coloma fine sand.....	11,648	2.3
Clyde fine sandy loam.....	11,520	2.3
Fox fine sand.....	9,344	1.8
Muck.....	8,448	1.7
Carrington fine sandy loam.....	6,720	1.3
Coloma fine sandy loam.....	6,592	1.3
Genesee fine sand.....	5,504	1.1
Clyde loam.....	4,096	.8
Dunning fine sandy loam.....	3,520	.6
Dunning loam.....	2,560	.5
Plainfield fine sandy loam.....	2,560	.5
Plainfield sand.....	2,240	.4
Fox silt loam.....	1,728	.3
Rough stony land.....	1,664	.3
Miami loam.....	1,536	.3
Boone sand.....	768	.2
Knox silt loam.....	768	.2
Fox fine sandy loam.....	704	.1
Plainfield sandy loam.....	640	.1
Clyde fine sand.....	640	.1
Genesee sand.....	512	.1
Total.....	511,360	

CHAPTER II

GROUP OF HEAVY, LIGHT-COLORED SOILS

MIAMI SILT LOAM

Extent and distribution.—The Miami silt loam is the most important type of soil in the county, occupying a total of 19.8 per cent of the entire area surveyed. The type as mapped in Columbia County has been divided into the typical soil and the deep phase. The deep phase, which is described later, is very similar to the deep phase as found elsewhere in the State. The portion of the type referred to as the typical soil, however, differs somewhat from the material which has heretofore been included with this type. The differences are due to topography and to the fact that the soil here is found near the border of the glaciated region, and was therefore not acted upon by the ice to so great an extent as most of the soils of the Miami series.

The portion of the type referred to as the typical soil covers an area of approximately 70 square miles and is confined to the western and southwestern portions of the county. By far the greater proportion of the country west of the Wisconsin River in Columbia County is made up of this soil. Another extensive tract occurs extending west from Lodi, along the south county line, to the Wisconsin River.

Description.—The surface soil to a depth of 8 or 10 inches consists of a light brown, friable silt loam containing only a moderate amount of organic matter. The subsoil is a yellowish-brown silt loam usually becoming heavier with depth and grading into a silty clay loam at 16 to 20 inches. This material may grade abruptly into a mixture of sand, gravel and clay at a depth of 20 to 24 inches or it may extend to bed rock, which is sometimes encountered at from 2½ to 4 feet. Over the bed rock which is usually sandstone there is frequently a layer of residual sand in place of glacial material, and over such areas the deep subsoil grades into sandy material. On steep slopes the underlying rock sometimes outcrops. In Caledonia Township the soil section is deeper than east of the river and rock can seldom be reached with the soil auger.

Topography and drainage.—The surface of this portion of the type varies from rolling to hilly. West of Lodi the surface becomes

quite rolling, while in Caledonia Township, west of the Wisconsin River, it is very rough, being broken by extensive ridges and hills. Differences in elevation of 600 feet within one mile are common. On some of the steep slopes there is danger of erosion, although up to the present time damage from this source has been comparatively small. On account of the uneven surface features the natural drainage is excellent. In a few places where the sandy material in the subsoil comes nearer the surface than usual the type may suffer somewhat from drought for short periods. Such areas, however, are of limited extent.

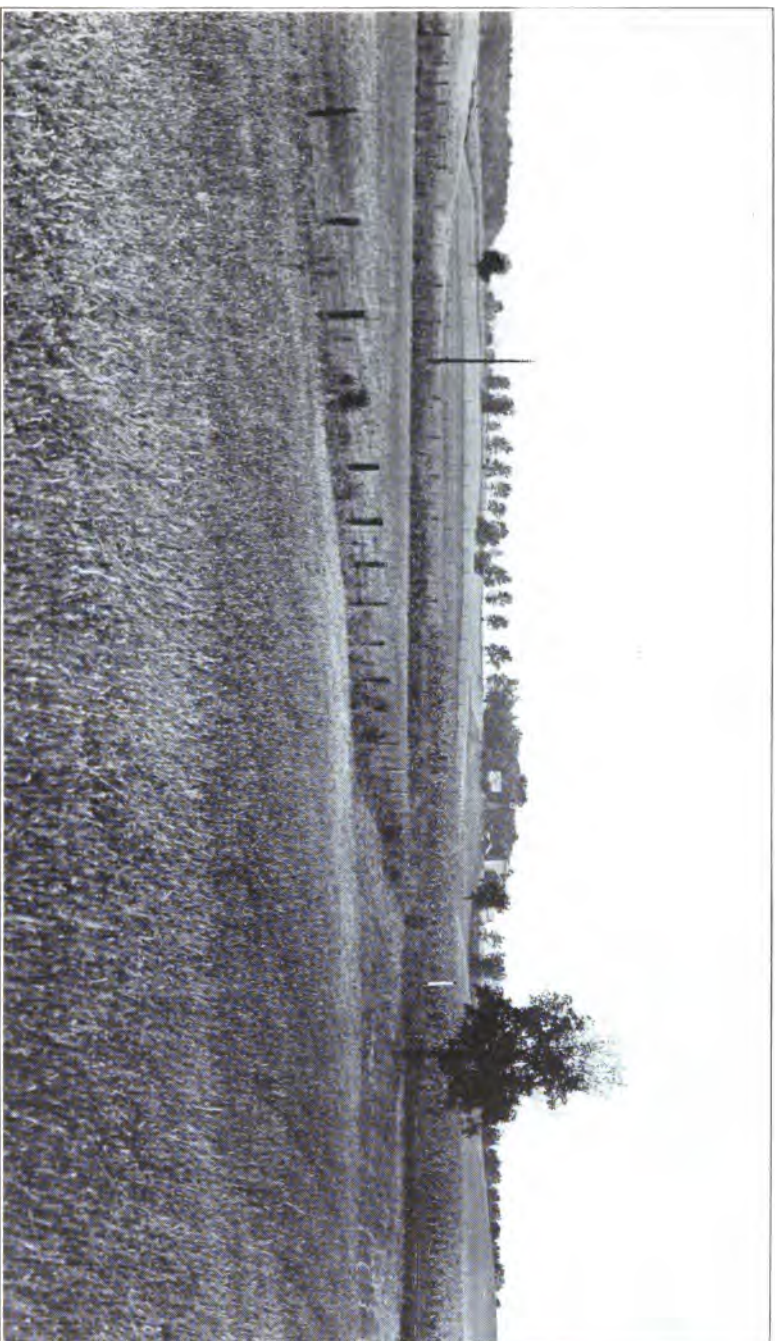
Origin.—The Miami silt loam has been derived from the weathering of a loess-like mantle overlying the glacial till, and to a greater or less extent from the weathering of the till itself. In addition to this, residual material from the underlying rocks has probably influenced the type to some extent. Under most of the type Potsdam sandstone is the bed rock, but there are also a number of small tracts where limestone forms the bed rock. Outcrops are frequently seen east of the river. In Caledonia Township the Huronian quartzite forms extensive ridges and outcrops were seen in places.

The amount of true glacial till in this region is much more limited than in the eastern portion of the county, and in places appears to be entirely lacking. At such points the loessial covering seems to have been laid down upon the bed rock, or upon material residual from the rock. It therefore has much the appearance of the Knox soils, which are loessial, although it is found entirely on the glaciated side of the terminal moraine.

There is not as much calcareous material in the subsoil as is typical for Miami silt loam, and in some places both soil and subsoil were found to be slightly acid.

Native Vegetation.—The type was originally covered with white, red, and burr oak, basswood, butternut, hickory and maple. Most of the land is now cleared and under cultivation, the uncleared portions being confined to the steepest slopes. The amount of saw timber remaining is limited, but there is a considerable amount which may be used as fuel.

Present Agricultural Development.—The Miami silt loam is one of the leading agricultural soils of southeastern Wisconsin. In this county the portion of the type in question is devoted chiefly to general farming with dairying, livestock raising, and feeding as the most important branches. The chief crops grown are corn, oats, hay, barley, and wheat, all of which produce profitable yields. Special crops, including beans, peas, tobacco, and sugar beats, are



VIEW OF MIAMI SILT LOAM, SHOWING CHARACTERISTIC TOPOGRAPHY, TYPICAL BUILDINGS AND
HIGHLY IMPROVED FIELDS.

There are over 100,000 acres of this type of soil in Columbia County. It includes a large proportion of the best farming land in the area surveyed.

sometimes grown but not to so great an extent as on the deep phase.

Because of steep slopes and rough land included in this type, especially in Caledonia Township, there is not as large a proportion of the soil highly improved as is the case with the deep phase.

MIAMI SILT LOAM, DEEP PHASE

Extent and distribution.—The Miami silt loam deep phase is one of the important soils of Columbia County, and with the Carrington silt loam it comprises the finest, and most highly improved land in the present survey. The largest tract is found in the southeastern corner of the county in the vicinity of Columbus. Other smaller tracts are found in the vicinity of Cambria and Randolph in the eastern part of the survey. All of the phase is confined to the eastern half of the area, and a considerable proportion of it is closely associated with the Carrington silt loam.

Description.—The surface soil of the Miami silt loam, deep phase, consists of a light-brown, friable silt loam about 10 inches deep, with a limited content of organic matter, but high in silt. The color of the soil varies with the moisture content, the surface presenting an ashy appearance when dry. The subsoil is a yellow silt loam, becoming heavier with depth and grading at 20 to 24 inches into a yellowish-brown silty clay loam. This material continues to a depth of 3 to 6 feet, where the true glacial till, consisting of a mixture of sand, silt, clay, and gravel, is encountered. The upper subsoil sometimes contains small lenses of very fine sand, while the lower subsoil may be slightly mottled with yellowish-red or brown, due to unequal oxidation of the material. There is a sharp line of demarcation between the loess-like material and the underlying true glacial till, stones, bowlders, or gravel being almost or entirely lacking in the upper portion, but rather numerous below. The gravel in the till consists chiefly of limestone.

While the phase as a whole is very uniform, there are some variations worthy of note. Where associated with the fine sand or fine sandy loam, the surface soil contains considerable fine sand and the subsoil may be a sandy clay at depths ranging from 16 to 36 inches, approaching more closely the subsoil of the Miami fine sandy loam than that of the true silt loam. Bordering Carrington silt loam, the Clyde soils, or where encountered on lower slopes and in depressions the surface and subsoils are somewhat darker than typical. The subsoil along the border of areas of Clyde silt loam is frequently pale yellow, with ferruginous mottlings. On the tops

and upper slopes of hills and ridges the surface soil is often more shallow than typical, while along the lower slopes the soil frequently reaches a depth of 12 to 16 inches.

The Miami silt loam, deep phase, resembles the Knox silt loam quite closely in color and texture and frequently has a loess-like structure. It is underlain, however, by true glacial till and derived in part at least from that source. The Miami silt loam, deep phase, also resembles the Carrington silt loam, in texture and structure and has nearly the same origin. It is light colored and was originally forested, while the Carrington soils are dark colored and are found chiefly in prairie regions.

This soil is comparatively easy to cultivate and when worked under favorable moisture conditions no difficulty is experienced in securing a good seed bed.

Topography and drainage.—The surface of the deep phase of Miami silt loam varies from gently undulating to gently rolling and sometimes rolling. Between Columbus and Randolph the type occupies the tops and sides of Drumlins, while for some distance west and southwest of Columbus it occupies all of the surface except the low, poorly drained areas, and the topography is only undulating to gently rolling. As a type the surface is sufficiently uneven to insure excellent natural surface drainage. There are a few draws and low places of small extent where tile drains could be installed to advantage.

Origin.—The deep phase is derived mainly from the weathering of the loessial mantle overlying the glacial till, and to a slight extent from the weathering of the till itself. The former shows no reaction with hydrochloric acid for limestone material, while the latter does. The surface shows traces of acidity, from which the till is free. This till bed, which varies in thickness from 2 to 100 feet, consists of a heterogeneous mass of boulders, gravel, rock fragments, silt, sand and clay. About 90 per cent of the gravel and almost all of the rock fragments and boulders are of limestone.

Native vegetation.—The type was originally covered with a growth of white, red, and bur oak, basswood, butternut, hickory, and maple. Most of the land is cleared.

Present agricultural development.—A large part of the soil is under cultivation, the nonarable land representing less than 1 per cent of the phase. General farming and dairying are the prevailing forms of agriculture. All of the general farm crops common to the region and several special crops are successfully grown. Corn, oats, barley, wheat, clover, and timothy give excellent results. From the standpoint of quality of the crops, the Miami silt loam, deep phase, is not

excelled by any of the other types in the county, although the Carrington silt loam and the Clyde silt loam will produce larger yields of some of the farm crops.

Corn, which is the leading crop, averages about 40 bushels to the acre, while oats, which rank next in importance, yield an average of 35 bushels. Barley has been extensively grown, but both the acreage and the average yields are on the decline at present, only about 20 bushels per acre being secured. Wheat is grown only to a limited extent and the yields are small.

A number of special crops on this type are yielding the growers satisfactory returns. In the vicinity of Columbus, Randolph, and Fall River peas for canning are being grown, yields ranging from 1,800 to 2,000 pounds per acre. When they are allowed to mature, the seed peas average about 15 bushels per acre. Beans are grown quite extensively and average about 20 bushels per acre. The yield of sugar beets ranges from 10 to 15 tons per acre of good quality, the sugar content being higher than from beets grown on the Carrington soils. Some tobacco is grown, yielding from 1,000 to 1,500 pounds per acre. Potatoes are grown to a limited extent and give fair yields.

The best farmers on this soil use a rotation consisting of corn followed by a small grain, such as oats, barley, or wheat, and then seeding with clover and timothy. Small grain may be grown for two years. Hay is cut for one or two years and may be pastured a year, after which the field is manured and again plowed for corn. When there is not sufficient manure a crop of clover or clover and timothy is frequently plowed under, which not only adds to the fertility but also increases the water-holding capacity of the soil. Although a number of farmers attempt to practice a definite rotation, there are many who do not make any special effort in this direction.

MIAMI LOAM

Description.—The surface soil of the Miami loam consists of a grayish-brown loam about 10 inches deep, carrying considerable fine sand and silt. The subsoil is a yellowish-brown sandy clay, becoming heavier with depth and continuing to about 2 feet, where the underlying till bed, consisting of sandy clay, gravel and boulders is encountered. This bed extends to a depth of many feet. Crystal-line and limestone boulders and rock fragments occur throughout the soil section and on the surface, but never in sufficient quantities to interfere with cultivation.

Where the type borders the Miami and Carrington silt loams the soil is silty and darker than usual.

Extent and distribution.—The type is not extensive and is confined to a few small areas in the eastern one-third of the county. The largest of these is found north of Cambria along the county line.

Topography and drainage.—The topography is for the most part gently rolling, and the natural drainage is good.

Origin.—The type has been derived from the weathering of the glacial till underlying this region. The surface soil is frequently in an acid condition which does not exist in the subsoil.

Native vegetation.—The original forest growth consisted of white, red, and bur oak, elm, basswood, butternut, and some hickory and poplar. Practically all of the best timber has been removed.

Present agricultural development.—About 70 per cent of the Miami loam is under cultivation, the remainder being mostly in pasture or gently rolling woodland.

The type is a very good general farming soil, and all of the crops common to the region can be grown upon it with satisfactory yields. Although tobacco, beans, and peas have been grown very little on this type, they give good yields.

The methods of farming are essentially the same as those practiced on the Miami silt loam.

FOX SILT LOAM

Extent and distribution.—The Fox silt loam is not extensive, occupying an area of only about 3 square miles. It occurs as a continuous body from one-half to 1 mile wide along the Baraboo River in the northern part of Caledonia Township. At a number of places this type grades into the Clyde silt loam. It resembles the Clyde in texture, but has a much lighter color.

Description.—The surface soil of the Fox silt loam consists of a brown silt loam, about 12 inches deep, having an extremely smooth feel. There is more organic matter present than is typical for this soil. Under normal moisture conditions the soil is quite friable, but when wet it becomes slightly sticky. The subsoil is a yellowish-brown silty clay loam, extending to a depth of 30 to 36 inches. The upper portion is high in silt and in many cases might be classed as a heavy silt loam. The clay content, however, increases with depth, and at about 2 feet the material is a silty clay loam. At 30 to 36 inches the heavy subsoil grades abruptly into a bed of fine sand of undetermined depth.

Over a small part of the type the surface has a yellowish to grayish-brown color and varies in depth from 10 to 14 inches. In places the underlying fine sand is encountered at 2 feet, although over most of the type it lies below the reach of a 3-foot auger.

Topography and drainage.—The topography is level, the only variation being a few old sloughs formed when the Baraboo River flowed at higher levels and through channels which changed from time to time. Natural drainage is somewhat defective. The river channel and the old sloughs, however, afford an excellent outlet for tile drains, which if properly installed would satisfactorily drain the entire type. The underlying bed of sand may furnish fair under-drainage, but it is often too deep to be of much help in this respect. The type is not subject to overflow, except during periods of extremely high water, which occur at intervals of 6 to 10 years. Such inundations affect only the portion lying immediately along the the river.

Origin.—The type represents sediments deposited by the waters of the Baraboo and Wisconsin Rivers when they flowed at higher levels than at present. The underlying sand was probably deposited by the Wisconsin River and the silty material by the Baraboo.

Native vegetation.—The original native vegetation consisted chiefly of elm, ash, hickory, and oak. Most of the good trees have been cut.

Present agricultural development.—Probably about 40 per cent of the type is under cultivation, the remainder being in forests and pastures. All of the type could be tilled if cleared, though the uncleared portion is in more danger of being flooded than the part now cultivated. The principal crops grown in the order of the rotation generally followed are corn, oats, and hay. No special attention is given to the selection of rotations best suited to this particular soil. The yields secured are reported to be slightly lower than on the Miami silt loam, deep phase, and the type is considered somewhat less desirable, chiefly on account of the danger of floods. The methods of cultivation and fertilization compare closely with those followed on the Miami silt loam, deep phase.

Under normal moisture conditions the type is comparatively easy to cultivate, although there are times in the spring when it becomes necessary to delay cultivating and planting until the land has drained. Less trouble and delay are experienced in this respect, however, than on the Clyde silt loam, with which the type is associated in the Baraboo Valley.

KNOX SILT LOAM

Extent and distribution.—The Knox silt loam is of very small extent, occupying a little over 1 square mile. It is confined to the vicinity of Kilbourn, in the northwestern corner of the county.

Description.—The surface soil of the Knox silt loam consists of a smooth, light brown to grayish silt loam, about 10 inches deep,

containing only a comparatively small quantity of organic matter. The subsoil consists of a yellowish-brown silt loam, becoming slightly heavier with depth and grading into a light silty clay loam below 18 inches. Below 2 feet small white mottlings are quite common. The underlying rock is not encountered within the 3-foot section at any point. The type is free from gravel, stones, and bowlders and is quite uniform throughout, although considerable fine sand is incorporated with it along the borders of adjoining sand types.

Topography and drainage.—The surface of the type is gently rolling. It is cut by several narrow gorges from 10 to 50 feet deep and gullied on the slopes. The natural drainage is good. On account of the silty character of the soil and the position which it occupies, the type is subject to erosion, and gullies once started advance rapidly during heavy rains.

Origin.—The type consists mainly of wind-blown loess material resting upon the Potsdam sandstone or residual sand from this rock. It is identical with the light-colored upland soils throughout the southwestern part of Wisconsin, and the same type has been mapped in Iowa and La Crosse Counties. The surface soil is usually in an acid condition.

Native vegetation.—The original forest growth consisted chiefly of white and red oak, hickory, and some basswood, with a few other varieties of hardwood. Practically all of this growth has been removed, except from some of the steeper slopes.

Present agricultural development.—Nearly all of the type is devoted to general farm crops or dairying. Yields compare favorably with those obtained on Miami silt loam. No systematic crop rotation is followed, but the same crop is seldom grown on the same field for more than two years in succession. Clover is grown every 7 or 8 years. All of the stable manure produced on the farm is applied to the soil, and some is hauled from Kilbourn. The soil works into a mellow seed bed without difficulty, if cultivated under the proper moisture conditions, though it will clod somewhat if plowed while too wet.

CHEMICAL COMPOSITION AND IMPROVEMENT OF MIAMI SILT LOAM, MIAMI LOAM, FOX SILT LOAM AND KNOX SILT LOAM

In texture, structure and color the soils of this group are quite similar, and in chemical composition they are also closely related. The total amount of phosphorus per acre in the surface 8 inches is somewhat lower than the amount found in highly productive soils,

it averaging about 1,200 pounds in all types, except the Fox silt loam where the total amount is considerably higher.

The total amount of potassium present is sufficient for the demands of growing crops for a long period of years, and ranges from about 30,000 to 40,000 pounds per acre. The problem of the potassium supply is to have a sufficient amount of decaying vegetable matter to produce the necessary chemical changes in the inert potassium compounds to make them available to plants.

This group of soils has a rather small amount of organic matter, and consequently a comparatively small amount of nitrogen, the average being about 3,000 pounds per acre in the surface 8 inches. In the Fox silt loam the amount of nitrogen is somewhat higher than the average of the other types.

The amount of lime or lime carbonate in these soils is variable. As a rule, many of the fields, especially those which have been cropped for a long period of years, have lost nearly or quite all of the lime originally contained in the surface soil, and have in numerous instances become acid. The subsoil, however, often still contains large amounts of this material, but for the insurance of a good growth of plants requiring lime, especially alfalfa, this will have to be supplied in all cases where the surface shows a distinct acid reaction, as indicated by the use of the litmus paper test, or the Truog* test for soil acidity.

In the improvement of this group of soil the factor which may well be given first consideration is a means for increasing the amount of organic matter and the supply of nitrogen. As the supply of stable manure is usually inadequate, it should be supplemented by green manuring crops, of which the legumes are best. Plowing under a second crop of clover once during each rotation will greatly assist in increasing the productivity of the soil. This will not only increase the supply of nitrogen in the soil but it will also improve the physical structure. The presence of a large amount of organic matter will also assist in making available for the plant a larger amount of potassium, which is present in sufficient amounts in these soils, but which is often in such a form as to be of little use to the plant.

A number of tests have been conducted which indicate that these types of soil will respond readily to the use of ground rock phosphate. This may be applied at the rate of from 500–1,000 pounds per acre, for the first application and somewhat smaller amounts once during each rotation. It may be applied with a fertilizer distributor

* The "Truog Test" for determining soil acidity is a new method which has just been perfected by E. Truog of the Soils Department of the University of Wisconsin, by which the relative degree of acidity can be accurately determined in the field or laboratory in a few minutes time. For a detailed description of this method write the Soils Department, College of Agriculture, Madison, Wis.

the same as ground limestone is sometimes applied, or it may be sprinkled on top of a load of manure in the manure spreader and scattered over the field in this way. It may also be sprinkled in the stables during the winter and taken up and hauled out with the manure. Phosphorus in this form is only slowly soluble so that there will be but little if any loss if larger applications than indicated are given.

Where an acid condition is found to exist on any of these soils this should be corrected by the use of some form of lime. Ground limestone rock will be found very effective, and this may be applied at the rate of from 1,000–2,000 pounds per acre or even more, depending upon the degree of acidity. The limestone may be applied at any convenient time as it is slowly soluble and will remain in the soil for a number of years.

Another factor of importance to be considered in the permanent improvement of these soils is that of thorough cultivation. Plowing should be done when the moisture conditions are favorable, and before a crop is planted the soil should be thoroughly pulverized, and the seed bed in a loose, mellow condition. All after cultivation of intertilled crops should be sufficiently frequent to keep down the weeds and also to maintain a good surface mulch to conserve the moisture and to permit the free circulation of air through the soil.

Attention should be given to the selection of crop rotations best suited to these soils and to the types of farming followed. A rotation in common use consists of corn, followed by a small grain for one or two years with which clover and timothy are seeded, and hay cut for two years. Another rotation which is suggested as being well suited to numerous farms consists of two years corn, one year oats or barley, and from three to four years of alfalfa, after which the field should be plowed and again put into corn. Stable manure when available should be applied to the sod land to be plowed for corn.

This group of soils makes up about 20 per cent of Columbia County, and includes some of the finest agricultural land in the area. It is important, therefore, that the fertility of these soils should be kept up and increased. These questions may well be given the careful consideration of every farmer on these types of soil.

CHAPTER III

SOILS OF THE PRAIRIE REGION

CARRINGTON SILT LOAM

Extent and Distribution.—Carrington silt loam is one of the leading agricultural types of southeastern Wisconsin, and is extensively developed in Fond du Lac, Dodge, Dane, Rock, Walworth, and Racine Counties and to a more limited extent in some of the other counties in this section of Wisconsin. The main area of the type in this county, comprising about 60 square miles, is found in the vicinity of Arlington and is known as Empire Prairie. Other areas are found northwest of Columbus and in the vicinity of Cambria.

Description.—The surface soil of the Carrington silt loam consists of a dark-brown to almost black friable silt loam, having a smooth feel and containing a large amount of organic matter. The subsoil consists of a dingy brown silt loam in the upper portion, becoming lighter in color and heavier in texture with depth, until at 20 to 24 inches it grades into a brownish or yellowish-brown silty clay loam or silty clay changing to yellow with traces of red at depths of 3 to 4 feet. The typical glacial till, consisting of clay, silt, sand, and boulders, is found at depths of 4 to 6 feet. The line of demarcation between the yellow silty clay and the unassorted till is well defined, the upper portion being free from boulders and gravel and leached free of calcium carbonate. The depth to bedrock ranges from 2 to 30 feet.

With the exception of a few small areas, the Carrington silt loam, is uniformly developed throughout its extent. Along the border of the fine sandy loam and loam members of the series both surface and subsoil contain considerable fine sand. Along the contact of the Miami silt loam, deep phase, the texture remains typical, but the color is lighter than usual. Where the Carrington silt loam is associated with the Clyde silt loam a number of steps appear in the weathering of the subsoil, grading from the dark or drab subsoil of the Clyde to the dingy brown or yellow of the Carrington. The water table becomes lower and soil oxidation more marked with improved drainage conditions. Over some of the limestone hills the soil is shallow, the soil mantle consisting of 7 to 10 inches of the dark-

colored silt loam, resting upon a dingy-brown silt loam which becomes heavier but lighter in color with depth. Both soil and subsoil in such areas contain limestone fragments with some outcrops of the bed rock, and over the eskers crystalline and limestone boulders and gravel are encountered.

The type resembles the Miami silt loam, deep phase, in texture, structure, and, to a certain extent, in mode of origin. It differs from the Miami, however, in that it is much darker in color, contains more organic matter, has a more nearly level topography, and occupies prairie regions instead of forested sections.

Topography and drainage.—The topography varies from level to gently undulating, the only exception to this is found in a few isolated groups of limestone hills which rise abruptly from 20 to 50 feet above the general level of the country, and in a few winding eskers filled with boulders and gravel.

Because of the undulating topography and long, gentle swells or slopes, erosion is not a factor of importance. There are but very few marshes within the areas of the Carrington silt loam, the drainage waters being largely carried beyond the limits of the prairies. The high organic-matter content and level surface of the type facilitates the rapid absorption of water, making cultivation easy under ordinarily careful management, and renders the soil more retentive of moisture. The underlying till and the gently undulating surface give fairly good natural drainage, though there are a number of places where tile could be installed to advantage.

Origin.—The material composing this type is derived from the weathering of the loess-like covering overlying the glacial till. The prairie regions were doubtless in a poorly drained condition before the streams and gullies had an opportunity to produce the present surface drainage and when the ground water stood at a higher level. The resulting moist condition prevented the growth of trees, but was suitable for grasses and sedges. The residue from the partial decay of this growth accounts for the high organic-matter content and the dark color of the soil. The calcium carbonate has been quite thoroughly leached from this soil, and the surface material is now in an acid condition.

Native vegetation.—Carrington silt loam is a prairie type, and the only forest growth upon it was confined to the borders of the prairies and on the limestone hills and ridges. The original growth consisted of some oak, hickory, and other hardwoods.

Present agricultural development.—With the exception of a very few isolated hills and ridges, all of the Carrington silt loam is under cultivation. It is highly improved and farming communities have



an appearance of thrift and prosperity. The type of agriculture followed consists chiefly of general farming, in conjunction with which a number of special crops are grown. The dairy industry is developed only to a limited extent, although present indications apparently favor its further development, with a corresponding reduction in some of the special crops, notably tobacco.

Of the general farm crops, corn yields about 42 bushels, oats 38 bushels, barley 30 bushels, wheat 15 bushels, and mixed timothy and clover hay about 2 tons to the acre. Some clover and timothy are grown separately, and the seed is occasionally allowed to mature. Only a very small amount of alfalfa is grown.

Tobacco is among the most important of the special crops grown, yields ranging from 1,000 to 1,600 pounds per acre, and the product selling for $2\frac{1}{2}$ to 14 cents per pound, according to quality and market conditions. Beans are grown quite extensively, yielding from 15 to 25 bushels per acre. Potatoes are grown only to a limited extent, chiefly for home use. The quality is not so good as when grown on the light-colored soils. The average yield is about 130 bushels per acre. Sugar beets are grown extensively in the vicinity of Arlington and south of the county line, yields ranging from 13 to 18 tons per acre. The sugar content averages about 14 per cent, which is 2 per cent below the average test of beets grown on the deep phase of the Miami silt loam. Larger yields on the Carrington silt loam, however, make this a more desirable soil for this crop. Cabbage does well on this type, and in the vicinity of Cambria, where extensively grown, yields of 12 to 14 tons per acre are secured. Seed peas average about 15 bushels per acre. A few peas are also grown for canning, but this industry is confined mainly to other soil types.

Comparatively few farmers follow a carefully worked out crop rotation, although where corn is followed by small grains, and the land then seeded to clover and timothy, and this sod well manured before again being plowed for corn, a marked improvement in the soil results. The special crops grown are usually inserted in the rotation without much thought as to their place. Tobacco is often grown on the same field for at least two or three years, and is usually followed by corn, potatoes, or beans. Owing to heavy applications of manure on the tobacco crop, good yields of the crops which follow are secured.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of Carrington silt loam:

Mechanical analyses of Carrington silt loam.

Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Soil.....	0.0	1.0	2.2	5.0	7.5	62.9	21.1
Subsoil.....	.4	1.5	4.2	11.5	5.5	58.1	18.5

CARRINGTON LOAM

Extent and distribution.—The Carrington loam is much less extensive than the Carrington silt loam with which it is associated. The largest areas are located several miles south and southwest of Rio, south of Cambria, and in the northeastern section of the county.

Description.—The surface soil of the Carrington loam is a dark-brown to black friable loam, from 10 to 12 inches deep, containing an appreciable amount of silt and fine sand and considerable organic matter. The upper portion of the subsoil consists of a dark-brown loam, grading at 16 inches into a compact, yellowish-brown sandy clay loam, which continues to a depth of 22 to 30 inches, where more sandy material is usually encountered, grading at 36 inches into a sandy clay. Small limestone fragments about the size of a pea are common at depths ranging from 20 to 36 inches. Limestone fragments and crystalline boulders occur throughout the soil section. The clay content is variable, in some cases being sufficient to make plowing difficult, except under favorable moisture conditions.

Topography and drainage.—The surface is undulating to gently rolling, the main body of the type being crossed by several gravelly ridges. Numerous small streams and gullies have formed an almost complete drainage system throughout the type. None of the type is sufficiently steep to suffer from erosion.

Origin.—The type has been derived from the weathering and disintegration of the underlying glacial till, which is encountered at depths of from 6 to 40 feet. The loess-like silty mantle overlying the till which is so conspicuous in the Carrington silt loam is not developed over this soil, except to a very small extent, the silt being insufficient to justify the classification of the type as a silt loam. Tests with litmus paper show a strong acid reaction.

Native vegetation.—As the type occupies an open prairie, there was practically no forest growth originally, the native vegetation consisting entirely of grasses.

Present agricultural development.—Although nearly all of this soil could be cultivated, the percentage of the area in farms is considerably less than is the case with the Carrington silt loam. Where the type is farmed the methods are poor and many of the fields are allowed to remain idle. About the same crops are grown as on the silt loam, but the yields are lower.

Probably a larger proportion of the farms on this type are devoted to dairying than on the silt loam, although the industry can not be said to be extensively developed.

No definite crop rotations are practiced on this soil. Rye is sometimes sown in the fall as a winter cover crop, and plowed under in the spring. Seeding is usually with oats or barley, as the amount of wheat now grown is small.

CARRINGTON FINE SANDY LOAM

Extent and Distribution.—This type is of minor importance in the county. It is associated with the Carrington loam and silt loam and the Miami fine sand and fine sandy loam.

Description.—The surface soil of Carrington fine sandy loam to an average depth of 11 inches consists of a dark-brown to black fine sand, containing considerable organic matter, which gives it a slightly loamy character. It is underlain by a lighter-colored fine sand, becoming sticky at a depth of 16 inches and heavier in the lower section, until at 2 or 3 feet it grades into a yellow friable fine sandy clay with a reddish tinge. Variations in depth occur over limited areas. Limestone fragments and crystalline bowlders are common throughout the soil section.

Topography and drainage.—The topography varies from undulating to gently rolling, and the surface is broken somewhat by small gravelly ridges. Natural drainage is good, although the type may be droughty over areas where the sandy clay is over 3 feet below the surface. It is less susceptible to drought than the Miami fine sandy loam under similar conditions, on account of the greater amount of organic matter in the surface soil.

Origin.—This type, like the Carrington loam, is derived from the weathering of the glacial till. The surface has probably been influenced to some extent by wind action. Tests indicate that the soil is acid and in need of lime.

Native vegetation.—The native vegetation consists chiefly of grass, with some bur oak, white oak, and poplar.

Present agricultural development.—Most of the general farm crops common to the region are grown upon this type, with fairly good

results. Corn averages about 35 bushels to the acre, oats 30 bushels, and hay 1½ tons. Of the special crops, potatoes yield about 125 bushels, beans 15 bushels, and tobacco 1,000 to 1,200 pounds per acre. Farming methods are similar to those employed on the Carrington loam. Little attention is paid to the question of crop rotations best suited to the soil.

CHEMICAL COMPOSITION AND IMPROVEMENT OF SOILS OF THE PRAIRIE REGION

In texture and structure the soils of this group are quite similar to those in the group of heavy light-colored soils, but they differ somewhat in their chemical composition. The amount of phosphorus is somewhat larger in the Carrington loam and silt loam than in the Miami silt loam, averaging about 1,600 pounds per acre in the surface 8 inches. The fine sandy loam contains a smaller amount of this element. The supply of potassium is large and practically the same as found in the heavy, light-colored group of soils. The supply of organic matter and nitrogen is often twice as large as is found in the light colored soils of the same texture. The larger amount of organic matter characterizing this type is probably the cause of the accumulation of somewhat larger amounts of phosphorus than contained in other types of soil having less humus. But it must be remembered that soils of this character which had originally a high degree of fertility on account of this large amount of organic matter, a considerable portion of which would decompose readily after the land was broken, lose this marked fertility as the result of a number of years of cropping, even though they still have a relatively large amount of humus. The humus remaining is of an inert resistant character which does not decompose readily and therefore does not serve the purpose of fresh vegetable matter. The phosphorus, although large in total amounts, is very commonly less available than in the lighter colored soils so that some form of fertilizer containing this element is usually needed to enable these soils to produce the best results.

On account of the large amount of organic matter which has decomposed in this soil it is almost universally acid, at least in the surface soil, and frequently this acidity is very considerable so that the use of relatively heavy applications of lime will be needed to fit such land for the growth of alfalfa and often even of medium red clover. Applications of from 2,000 to 4,000 pounds of ground limestone per acre will usually be sufficient to correct the acidity, but in some cases a larger amount than this may be necessary. There is

an abundant supply of limestone close at hand throughout the regions covered by this soil, and by cooperation among the farmers it may be crushed at a very small cost.

The use of ground rock phosphate, as a source of phosphorus, has been found to give good results on Carrington silt loam. Its use should be extended to all areas of this soil, since by supplementing the stable manure with this commercial fertilizer the productivity of the soil can be materially increased. About 600 pounds per acre will usually be found sufficient for the first application. Smaller applications can be made once during each succeeding rotation. As the phosphorus in this form is only slowly soluble it will remain in the soil for a number of years, and but little will be carried away by the drainage waters.

As indicated by the analyses made of this soil, and referred to above, there is a large amount of organic matter present but the humus remaining is of an inert resistant character and as in this form it decomposes slowly it is of little value to growing crops. The organic matter supply of this type should therefore be supplemented by fresh vegetable matter in the form of green manuring crops, of which the legumes are best. As the fresh vegetable matter decomposes it will also assist in making available larger amounts of potassium. It will be found that by supplementing the stable manure with green manuring crops and rock phosphate that the fertility of Carrington silt loam will be greatly increased, and the margin of profit in farming this soil will be considerably larger.

Another factor which may well be considered in the improving of this soil type is the question of tile drains. There are a number of places where the surface is nearly level or undulating, and where the subsoil is sufficiently heavy so that the internal movement of water is sluggish. This frequently delays planting and cultivation in the spring, and keeps the ground cold so that plant growth is checked and crop yields reduced as a result of this condition. Tile drains are not at all common on this soil, but their use should be encouraged, since they will greatly assist in improving the physical condition of the soil, permit low places to warm up and dry out quickly in the spring, and permit the uniform development of a crop over all parts of fields.

The following rotation is one which gives good results on this soil, and may well be followed as given here, or it may be used as a basis for working out other rotations to fit special needs. Small grains consisting of oats, barley, or wheat may be grown the first year and seeded with a mixture of clover and timothy. The second year the first crop of clover may be cut for hay, and the second left for

seed. The third year a crop of mixed clover and timothy can be harvested. The field may then be pastured a year, or manure may be applied to the sod either before the land is plowed in the fall or on the plowed land during the winter. The following year corn may be grown. When it is desired to plow under a crop of clover this may be done by following a three year rotation. In this case only clover should be seeded with the grain. The first crop of clover should be cut for hay, and the second plowed under. The following year corn or some other cultivated crop may be grown. Two grain crops may be used in such a rotation, extending it over 4 years.

The dairy industry has not been developed to as great an extent on these soils in Columbia County as in some other portions of the State. This industry could be profitably extended, and with it should be extended the growing of alfalfa.

When the soil is limed and inoculated, and in a good state of fertility this crop does very well. Special crops such as peas and cabbage as are now being grown in certain localities could well be grown on a larger scale. The Carrington silt loam may well be considered one of the best agricultural soils in the State, and it is doubtless well adapted to a wider range of crops than are now being grown. It is therefore desirable and important that the questions of crop adaptation and methods of improvement should be given careful consideration by all who are interested in this type of soil.

CHAPTER IV

GROUP OF FINE SANDY LOAM SOILS

MIAMI FINE SANDY LOAM

Extent and distribution.—The Miami fine sandy loam is the most extensive type in the county and is important from an agricultural standpoint. Large areas are found in the central and north-central parts of the county. One area extends from a point a few miles north of Portage eastward to within 4 or 5 miles of the northeast corner of the county. Another large area occurs in the vicinity of Doylestown, extending westward to the Wisconsin River and north to Duck Creek. Other smaller areas are scattered throughout the county, with the exception of the extreme northwest and the extreme southeast corners and the prairie regions.

The type may be said to represent a gradation from the silty-soils of the southern, eastern, and western parts of the county toward the fine sand types with which it is associated. Its continuity is frequently broken by low, level, and poorly drained areas embracing Peat, Muck, and the Clyde soils, and also by level sandy areas where soils of the Plainfield and Fox series are encountered.

Description.—The surface soil of the Miami fine sandy loam consists of a loose, porous, light-brown fine sand or light fine sandy loam about 10 inches deep, containing only a small amount of organic matter. The material is usually rather loose and the downward movement of water through the surface soil is rapid. The subsoil consists of a yellowish or yellowish-brown fine sand, slightly sticky at depths of 15 to 20 inches, and which grades into a compact reddish-brown or dark-brown sandy clay at 20 to 36 inches. The deeper portion consists of a mixture of sand, gravel, stones, and clay and extends to considerable depths, as indicated by road cuts and well borings. Boulders, rock fragments, and pebbles of limestone origin are found throughout the soil section, but rarely in quantities to interfere with cultivation.

On the lower slopes of hills and ridges and the lower-lying portions of the type where the water table approaches the surface the soil is darker in color, due to accumulations of organic matter. The underlying sandy clay occurs at depths of 1 to 3 feet. At a few points along the northern boundary of the county a red clay similar

to the Superior clay was encountered at a depth of 2 to 3 feet. All of these variations are of comparatively small extent, as compared with the area of the whole type, and while they affect to some degree the agricultural value of the type the difference is not great enough to justify their separation.

Topography and drainage.—The topography varies from gently rolling to rolling. This feature, in conjunction with the sandy nature of the soil and the sand and gravel in the subsoil, accounts for excellent natural drainage. Over the deeper areas of sand the type is inclined to be droughty, but where the underlying sandy clay approaches the surface the ability of the soil to withstand drought is nearly equal to that of the Miami silt loam.

The rainfall is readily absorbed by the sandy soil, except during unusually heavy precipitations when there is some surface run-off through regular drainage channels. No damage from erosion results except on the steepest hillsides.

Origin.—The type has been derived from the weathering of the unsorted glacial till modified by lateral and recessional morainic material. Where the sand is deepest the surface has been influenced somewhat by wind action, although this feature is not so pronounced as on the Miami fine sand. Although there is considerable limestone material mixed with the gravel, the type shows traces of acidity over much of its extent.

Native vegetation.—The original forest growth consisted chiefly of white, red, and bur oak, hickory, maple, and butternut, with some elm in the lower areas. Practically all of this has been removed and the land placed under cultivation.

Present agricultural developments.—With the exception of a few pasture woodlots on the rougher areas the Miami fine sandy loam is practically all under cultivation. The prevailing type of agriculture consists of general farming and the growing of a few special crops. Dairying, though gradually extending, is still of minor importance.

The general farm crops most commonly grown are corn, which averages 35 bushels; oats, 30 bushels; barley, 30 bushels; wheat, 17 bushels; rye, 20 bushels; and timothy and clover mixed, about 1½ tons per acre.

Of the special crops beans yield from 20 to 35 bushels, Irish potatoes about 125 bushels, and tobacco from 1,000 to 1,300 pounds per acre. The quality of the tobacco grown is superior to that produced on the Carrington silt loam.

There is a wide variation in methods of cultivation on this soil, and as yet no definite rotation has been worked out which proves



VIEW OF MIAMI FINE SANDY LOAM, NORTHEAST OF POYNETTE, SHOWING CHARACTERISTIC GENTLY ROLLING TO ROLLING SURFACE, AND TYPICAL FARM BUILDINGS

This is the most extensive type of soil in Columbia County, there being over 110,000 acres, but it is not equal in productiveness to, nor as extensively developed as, the Miami and Carrington silt loams.

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especially adapted to local conditions. It is customary to plant corn or potatoes on fields which have been in sod. If potatoes are planted first this crop may be followed by corn, after which a small grain, such as oats, barley, wheat, or rye, is grown, followed a second year by a small grain with which timothy and clover are seeded. Hay is cut for one or two years, or the field pastured the second year, before being plowed again. Beans are usually sown in fields following sod to which a good supply of manure has been added.

Stable manure is the only fertilizer used on this soil to any extent. A crop of clover is plowed under occasionally, but the practice of green manuring is not at all common. When tobacco is grown manure is liberally applied and frequently at the expense of the remainder of the farm.

COLOMA FINE SANDY LOAM

Extent and distribution.—This type is confined to Newport and Lewiston Townships, in the northwestern part of the county, where it is associated with the Coloma fine sand. It is of comparatively small extent, having a total area of only 6 or 8 square miles.

Description.—The surface soil of the Coloma fine sandy loam consists of a light-brown to gray light fine sandy loam or fine sand, about 10 inches deep. The material is open and loose in structure and low in organic matter. The subsoil is a light-yellow or pale, reddish-yellow fine sand, which becomes sticky at 15 to 20 inches and grades into a compact reddish or yellowish-brown sandy clay at 22 to 36 inches. Crystalline rock fragments, gravel, and bowlders and some chert and sandstone fragments occur on the surface and throughout the soil section, but not in quantities sufficient to interfere with cultivation. The gravel and rock fragments are more plentiful in the subsoil than in the surface section, being sufficiently numerous in places to interfere with boring.

The lower slopes and depressions bordering the lowlands show a darker surface soil, due to accumulations of organic matter. In small areas on some of the narrow hilltops and steeper slopes the sandy covering has been eroded, leaving exposed the sandy clay subsoil. In other places the sandy covering is shallower than typical. In a few places the sticky sandy subsoil was not encountered above 24 to 28 inches, but all of these variations are of small extent and could not be indicated separately. A small area of sandy soil underlain at a depth of 2 feet by Superior clay was found along the northern boundary in Lewiston Township. This area was too small to be separated on the map.

The Coloma fine sandy loam is similar in texture, structure, and topography to the Miami fine sandy loam, but differs from that type in that it does not contain any appreciable amount of limestone material.

Topography and drainage.—The surface of the type is gently rolling to rolling and dotted with marshes and depressions into which the drainage waters find their way. On account of the topography and the texture of the soil, the natural drainage is excellent. There is sufficient silt and clay in the subsoil to make the type quite retentive of moisture, and it seldom suffers from drought except during the most extended dry periods. On the steeper slopes the surface has been eroded in places and small gullies formed, though the damage from this source is slight.

Origin.—The Coloma fine sandy loam is derived from the weathering of glacial till, some of which doubtless represents terminal and recessional moraines. The material is unassorted, the rock fragments and boulders consisting of granite, gneiss, quartz, sandstone, and a number of other rocks. Limestone is found in this drift only in small quantities. In most places Potsdam sandstone constitutes the parent rock. Litmus tests indicate that the soil material is acid.

Native vegetation.—The original forest growth consisted chiefly of white, red, and bur oak, with some hickory and other varieties of hardwood. There are still some woodlots on this type, but all of the best trees have been removed.

Present agricultural development.—With the exception of some of the steeper slopes, kettle basins, and woodlots, which are all of small extent, the type is largely under cultivation, and all of the general farm crops common to the region are grown. The methods of cultivation, fertilization, and crop rotations followed are similar to those practiced on the Miami fine sandy loam, though as a whole this type is somewhat less productive than the Miami.

The chief type of agriculture followed consists of general farming, with a tendency toward an increase in the dairy industry, which at present is not extensively developed.

FOX FINE SANDY LOAM

The only area of this soil in the county lies south of Pardeeville and covers a little more than a square mile.

The Fox fine sandy loam, to an average depth of 10 inches, consists of a brown fine sandy loam, containing enough silt and clay to make it slightly sticky when wet. The organic-matter content

is higher than in the fine sand type. The subsoil is lighter in color than the soil and is a fine sandy loam in texture, becoming heavier in depth to a light sandy clay at 2 feet. Below this the texture becomes lighter again, becoming fine sand at less than 5 feet, though the details of texture in the subsoil are not uniform.

The topography is smooth and the natural drainage good, this being effected main'y through the soil.

In origin this soil seems to be derived from an area of glacial outwash material. It lies from 10 to 15 feet above the level of Fox River.

All of the area is in cultivation and gives fair yields of the general farm crops.

The methods of cultivation, crop rotation, etc., are practically the same as on the Miami fine sandy loam.

PLAINFIELD FINE SANDY LOAM

Extent and distribution.—The type is of small extent, comprising less than 4 square miles. The largest area lies direct'y south of Portage, on the south side of the Wisconsin River.

Description.—The surface soil of the Plainfield fine sandy loam to an average depth of 10 inches consists of a brown fine sandy loam containing enough silt and clay to make it slightly sticky when wet. The organic-matter content is higher than in the fine sand type. The subsoil is a fine sandy loam, lighter in color than the soil, and gradually becoming heavier in texture until a light sandy clay is encountered at a depth of 2 feet. Below this the material again becomes lighter and grades into a bed of fine sand at less than 5 feet. The type is subject to some variation, especially in the character of the subsoil. The surface soil is uniformly a fine sandy loam, but frequently the subsoil below 16 or 18 inches is a fine sand.

Topography and drainage.—The topography is level or slightly undulating and the natural drainage is good. South of Portage there are low-lying areas where the water table is comparatively near the surface, so that there is frequently an excess of moisture, especially in the spring and early summer.

Origin.—The soil represents stream-laid material deposited when the river flowed at higher levels than at present. All the areas occur within the Wisconsin River Valley, but the largest area, the one south of Portage, is protected from overflow by a levee. Litmus tests indicate that the soil is acid.

Native vegetation.—The original forest growth consisted chiefly of white and red oak, with some hickory and other hardwoods.

Much of the type along the Wisconsin River is now in wood lot or pasture.

Present agricultural development.—About one-third of the type is under cultivation to the general farm crops. South of Portage much of the type is wet early in the season. It is used chiefly for hay and pasture.

Average yields are lower than on Miami fine sandy loam.

CHEMICAL COMPOSITION AND IMPROVEMENT OF FINE SANDY LOAM SOILS

Chemical analyses indicate that the soils of this group contain smaller amounts of all the essential plant food elements than are found in the group of heavy, light-colored soils, and that these types are deficient in most of the elements required by growing crops. The phosphorus content in the Miami and Fox fine sandy loams will average 900 pounds per acre in the surface 8 inches, while the amount present in Coloma and Plainfield fine sandy loams is somewhat smaller. In highly productive soils there is usually nearly twice this amount.

The supply of potassium in this group of soils may be considered as a fair amount in most cases and possibly sufficient for the demands of growing crops when proper methods of cultivation are followed. The amount usually ranges from about 25,000 to 35,000 pounds per acre, with the Coloma and Plainfield fine sandy loams frequently falling below these figures.

The amount of organic matter and nitrogen in most of these types is small, the average being about 1500 pounds per acre or about half the amount found in Miami loam and silt loam. The Fox fine sandy loam contains a somewhat larger amount than the average for this group, but is still deficient in nitrogen.

In the Miami and Fox soils the lime content was originally high, many of the coarser particles being made up of limestone. The surface soils, however, have been leached to a considerable extent so that in places an acid condition is found to exist. The Coloma and Plainfield soils are usually acid. An acid condition may be readily corrected by the use of ground limestone. One ton per acre will doubtless be sufficient to correct the acidity, except where it is most pronounced.

One of the greatest needs of the soils in this group is a larger supply of organic matter. This may be supplied by supplementing the stable manure, the amount of which is usually limited, with green manuring crops of which legumes are best. This decaying vegetable

matter will increase the water-holding capacity of the soil and it will also assist in making available for the plants some of the potassium and phosphorus which is securely locked up by various chemical combinations.

The phosphorus supply may be increased by the use of ground rock phosphate, which should be applied at the rate of about 500 to 600 pounds per acre for the first time, followed by smaller applications once during each rotation.

Careful attention should be given to the selection of crop rotations best suited to these soils. Where the location is suitable, and where there are adequate facilities for marketing, the trucking industry could be developed on a commercial scale. Bush berries and strawberries thrive and their culture should be encouraged. Where general farming and dairying are the chief lines of agriculture followed, as is usually the case, the growing of alfalfa should be extended, after the soil has been fertilized, inoculated, and limed where necessary.

CHAPTER V

GROUP OF SAND AND FINE SAND SOILS

MIAMI FINE SAND

Extent and distribution.—The Miami fine sand is most extensively developed in the central part of the county, in Pacific and Wyocena Townships, with scattered areas in Fort Winnebago, Marcellon, Lowville, Dekorra, and the northern part of Lodi Townships. There are only a very few areas in the eastern third of the county or along the southern border, where the Carrington silt loam and Miami silt loam predominate. The type is associated with the Miami fine sandy loam and its continuity is frequently broken by areas of Peat, the Clyde series, or in some places by level, sandy tracts of Plainfield or Fox soils.

Description.—The Miami fine sand consists of a light-brown, loose, fine sand, which is low in organic matter. At about 9 to 10 inches the material is light yellow, becoming lighter with depth, until at 30 to 36 inches it is an almost white fine sand of loose and open structure. The till bed, consisting of a mixture of sand, gravel, silt, and boulders, is encountered at depths of 4 to 6 feet. Small quantities of limestone, gravel and boulders occur on the surface and throughout the soil section but are seldom sufficiently numerous to interfere with cultivation.

The type is subject to some variation, though none of the phases were of sufficient extent or importance to indicate separately on the map. On the lower slopes and in depressions the surface is darker and contains a larger amount of organic matter than the typical soil. Such areas are slightly loamy and have a somewhat higher agricultural value than the rest of the type. In a few places a sticky sand is encountered at a depth of 30 to 36 inches. A few gravel beds are scattered throughout the type, such deposits having only a shallow surface covering of soil. Exposed areas are sometimes wind-drifted, small dunes being formed. In general the Miami sand is lighter in texture and lower in agricultural value than the Miami fine sandy loam, with which it is closely associated.

Topography and drainage.—The topography of the type varies from gently rolling to rolling. The surface is sometimes broken by sand dunes and depressions, though rarely to such an extent as

to render cultivation impracticable. Owing to the loose open structure of the material and to the surface configuration, the natural drainage is excessive and the soil as a whole is droughty. There are only a few kettle basins and dune depressions which are not connected with drainage channels, and even in these places the drainage is usually sufficient, owing to the sandy nature of the deeper subsoil. Except during the heaviest rains, storm waters are rapidly absorbed by the soil, and danger from erosion through surface run-off is reduced to a minimum.

Origin.—The type is largely of glacial origin and has been derived from the weathering of the glacial till, somewhat modified by wind and steam action. The weathering of the limestone fragments in the underlying till has a tendency to correct any acidity existing in the soil material, though this is often counteracted by leaching, leaving the type more or less acid.

Native vegetation.—The original forest growth consisted chiefly of white, red and bur oak, with some hickory, and hazel brush. All of the merchantable timber has been cut, but the scrubby growth of oak and hazel bushes has been allowed to remain on a few of the poorest portions of the type.

Present agricultural development.—About 75 per cent of the type is under cultivation, while approximately 22 per cent remains in untilled pasture land. About 2 per cent consists of sand dunes and about 1 per cent of moraines, kettle basins, and regions too stony and rough to be of any value except for pasture.

The general farm crops common to the region are grown. Corn under normal conditions will average 25 bushels to the acre, oats 22 bushels, rye 12 bushels, and timothy and clover about 1 ton. Potatoes yield as high as 150 to 175 bushels per acre when given special attention, though the average is lower than this for the whole type. Beans and tobacco, which are grown quite extensively on the fine sandy loam, are not grown to any great extent on the fine sand, and the yields are considerably lower. Cucumbers do well and satisfactory yields are secured, though the crop is not grown very extensively.

No definite crop rotation is practiced on this type as a whole. Where manure is available it is usually applied to the sod. Green manuring is not practiced to any extent and commercial fertilizers are seldom used. A rotation which has given success consists of potatoes, followed by a small grain, such as rye or oats, and the land seeded to clover. The first crop of clover may be cut for hay and the second plowed under for green manuring. If sufficient manure is available the second crop of clover may be left for seed. Corn may be grown in place of potatoes if desired.

COLOMA FINE SAND

Extent and distribution.—This type is confined to the northwestern part of the county, in Newport, Lewiston, and Fort Winnebago Townships. All of the type lies west of the Fox and north of the Wisconsin Rivers. It is closely associated with Coloma fine sandy loam.

Description.—The surface soil of Coloma fine sand, to an average depth of 9 inches consists of a loose, light-brown fine sand, containing but little organic matter. The subsoil is a loose, fine sand, 3 feet or more in depth, and grading from a light brown to a light yellow as the lower portion is approached. Crystalline and sandstone gravel and rock fragments occur in both soil and subsoil, but in quantities too small to interfere with cultivation. A few gravel beds covered by a thin mantle of surface soil are found throughout the type. This type differs from the Miami fine sand in the absence of limestone gravel or rock fragments.

The organic-matter content varies over different sections of the type, being higher in the depressions where the moisture conditions have favored the accumulation of humus-forming material. Where lenses of clay in the underlying till occur at depths of 3 to 5 feet below the surface the type is not quite so droughty as where the sand is of greater depth. Small dunes formed by wind-blown sand are occasionally found.

Topography and drainage.—The surface of the type varies from gently rolling to rolling. On account of its loose, open structure the natural drainage is somewhat excessive and the type is likely to suffer from drought, except during seasons of excessive rainfall. Erosion is not a serious problem on this type, the rainfall being rapidly absorbed and the surface run-off reduced to a minimum.

Origin.—The material composing Coloma fine sand consists of glacial debris, most of which occurs in the form of lateral and recessional moraines. The glacial debris here is very largely made up of fine sand, due to the fact that prior to this deposition the ice passed over the Potsdam sandstone, grinding off the rock and transporting the material for some distance. The soil and subsoil of Coloma fine sand contain no limestone material and are usually more acid than the corresponding type of the Miami series.

Native vegetation.—The original forest growth consisted chiefly of white, red, and bur oak, with some hickory and other hardwoods. Part of the area is now overgrown with hazel brush. A few woodlots remain, but most of the forest has been cut.

Present agricultural development.—About 60 per cent of the Coloma fine sand is under cultivation to the general farm crops common to this region.

Over most of the type but little attention is given to the selection of a rotation particularly adapted to this soil. The methods of cultivation are similar to those followed on the other sandy types of the county. The soil is loose and open and very easily cultivated. Average yields are low.

It may be said of this type as a whole that the methods now followed upon it are not such as tend to increase its productivity, although there are exceptions where more up-to-date methods are being practiced.

The following table shows the results of mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Coloma fine sand.

Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Soil.....	0.2	9.5	22.4	56.7	3.8	4.6	2.5
Subsoil.....	.0	6.2	19.4	64.0	5.3	3.4	1.6

PLAINFIELD SANDY LOAM*

Extent and distribution.—This type is inextensive and of little importance. The most important area, containing about 1 square mile, is found in the northern part of Newport Township, along the county line, 5 miles east of Kilbourn. A small patch one-half square mile in extent, occurs directly across the river from Portage.

Description.—The surface soil of the Plainfield sandy loam consists of a brown to dark-brown sand, of loose, open structure about 8 inches deep. The subsoil is a brownish-yellow sand, to a depth of 2 feet, where it becomes sticky and slightly coarser, often grading into a sandy clay, which becomes heavy and plastic at 30 to 36 inches. Gravel beds and lenses of sand and gravel are found in the subsoil and evidences of stratification are frequently apparent.

Topography and drainage.—The topography is level to undulating, the surface having been influenced somewhat by wind action, which has formed low ridges. The intervening depressions are sometimes without surface drainage, but the ridges are well drained and in places droughty. The area near Portage is level and a part of it is in need of tile drainage.

* This type has been grouped with the sands and fine sands because of its limited extent, and because it is quite similar in agricultural value to the fine sand types.

Origin.—The type has the same origin as the Plainfield sand and represents valley fill of the old Wisconsin River. The area east of Kilbourn lies at about the same elevation as the Plainfield sand area in that region, while the tract south of Portage is much lower. The litmus test indicates that the surface soil is acid.

Native vegetation.—The original forest growth was similar to that found on the Plainfield sand.

Present agricultural development.—Most of the type is under cultivation to the general farm crops. Few farmers continue the same crop for more than two years and clover is grown every 6 to 7 years. The soil, particularly on the higher areas, does not seem to be well suited to grasses, but truck crops do well. The soil is easy to cultivate, and with careful methods good yields are secured.

PLAINFIELD FINE SAND

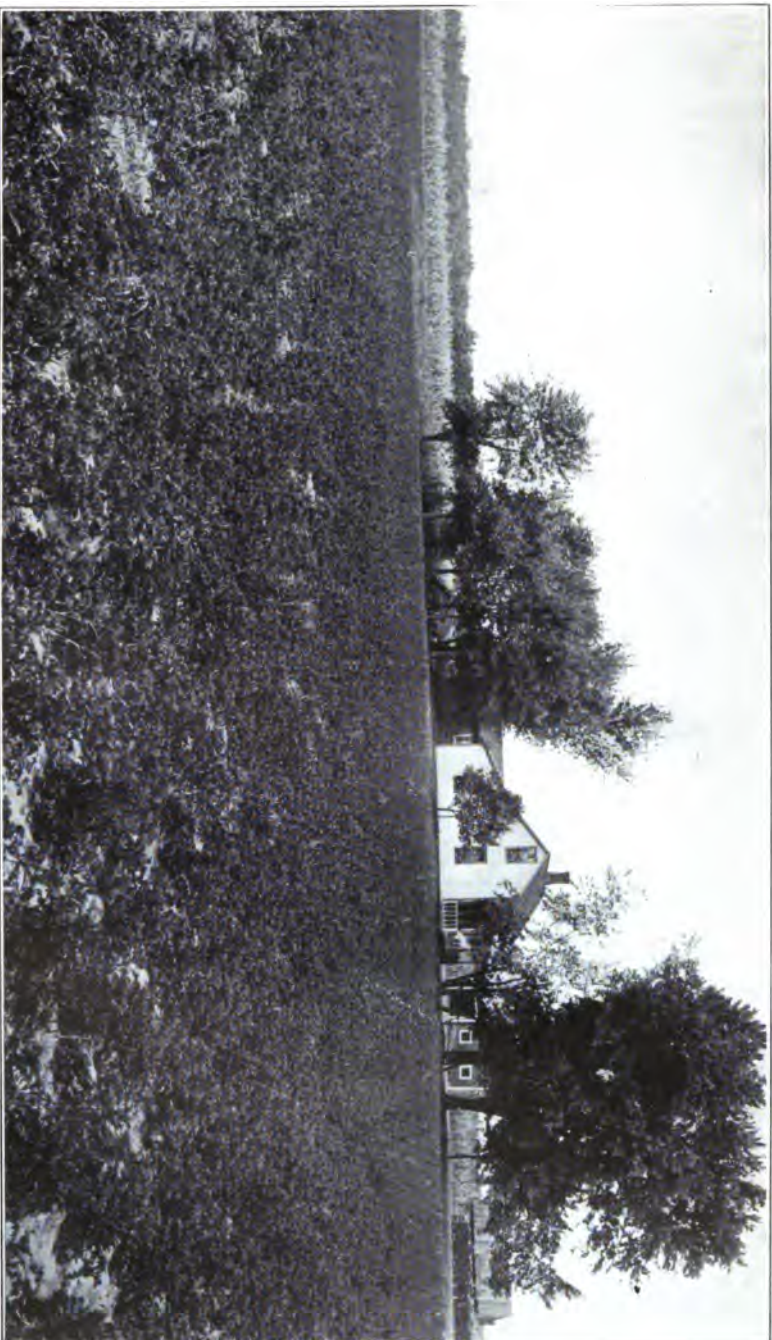
Extent and distribution.—The largest bodies of this type are found in Lewiston Township along the headwaters of the south branch of Neenah Creek, and occupy the level lands southward to the Wisconsin River. The other areas occur along both sides of the Wisconsin River to the west and south of Portage both in and out of the river valley.

Description.—The surface soil of the Plainfield fine sand is a loose, light-brown fine sand, about 10 inches deep. It is free from gravel and stones and contains very little organic matter. The subsoil is a yellow fine sand. The material is loose and becomes lighter in color with depth. It contains lenses or thin beds of stratified gravel. At depths of 2 to 3 feet large gravel beds are sometimes encountered. The lower lying areas are darker in color, owing to accumulations of organic matter.

Topography and drainage.—The topography is comparatively level, with some undulations, due chiefly to wind action which has formed low sand ridges and dunes. On account of the loose, open structure of the soil, the natural drainage is complete and sometimes excessive, especially on the higher portions of the type.

Origin.—The Plainfield fine sand consists chiefly of reworked glacial material redeposited by water action in old valley flood plains, old valley fills, and outwash plains. The parent rock, from which most of the material has been eroded by glacial action, consists chiefly of Potsdam sandstone. The surface soil of this type shows acidity when tested with litmus paper.

Native vegetation.—The original forest growth consisted largely of oaks and poplar, with some sycamore, elm, and willows in the



VIEW SHOWING CHARACTERISTIC LEVEL SURFACE OF THE PLAINFIELD FINE SAND. EXTENSIVELY FOUND IN THE VICINITY OF LEWISTON.

The surface features are characteristic of the Fox soils as well as of the Plainfield types. This soil requires careful management, but when properly cultivated and fertilized profitable crops can be grown.

lower situations where the water table approaches the surface more closely than usual.

Present agricultural development.—More than half of the type is under cultivation to the general farm crops, of which corn yields an average of 25 bushels, oats 20 bushels, rye 15 bushels, potatoes 100 bushels, wheat 12 bushels, buckwheat 15 bushels, and hay about 1 ton per acre. Of the special crops, tobacco yields from 1,000 to 2,000 pounds per acre and beans average about 12 to 15 bushels. Some trucking is practiced over a part of the type. Where a heavy dressing of stable manure is applied, cucumbers yield as high as 125 to 150 bushels per acre. Very little has been done in the line of selecting crop rotations adapted to this particular type and present farming methods are not such as tend to increase the productivity of the soil.

PLAINFIELD SAND

Extent and distribution.—This type is of limited extent and confined to the northwestern corner of the county, east of Kilbourn, where it covers an area of some 3 square miles. Another small tract of less than a square mile is found on the south side of the Wisconsin River at Portage.

Description.—The surface soil of the Plainfield sand consists of a light-brown, loose sand of medium texture extending to an average depth of 9 inches and containing only a very small amount of organic matter. The subsoil consists of a yellow, medium sand, becoming lighter in color with depth. The material is loose and becomes coarser at depths of 18 to 30 inches, and lenses of gravel are encountered at 3 to 4 feet. No stones of over a few inches in diameter are present in either soil or subsoil, and limestone fragments are absent, the gravel consisting chiefly of quartz, flint, chert, quartzite, argillite, gabbro, and a few other rocks.

Topography and drainage.—The surface of the type was originally level or nearly so, but has been modified by wind action until at present it consists of drifts, hummocks, and intervening depressions with some level stretches. Differences in elevation rarely exceed 30 feet and are usually considerably less. The depressions have no surface drainage, but over the remainder of the type the natural drainage is good, frequently being excessive. The area south of Portage is level.

Origin.—At Kilbourn the type represents a river fill of the old Wisconsin River from 160 to 190 feet above its present level. The area south of Portage is only a little above the present level of the

river. All of the soil material has been reworked and deposited by water action when the river flowed at higher levels. The parent rock from which much of the sand was derived is the Potsdam sandstone. The type as a whole is in an acid condition.

Native vegetation.—The original forest growth consisted chiefly of burr, white, and red oaks, hickory, and poplar.

Present agricultural development.—Not over 35 per cent of the type is under cultivation. During favorable seasons, and when properly fertilized and cultivated, fair yields are obtained. Average yields are low and the type as cultivated is not well adapted to general farm crops, being droughty and of low fertility. Potatoes do fairly well and truck crops give fair returns when properly cared for.

FOX FINE SAND

Extent and distribution.—This type occurs rather well distributed in a north and south belt extending across the central part of the county. The largest area lies in the vicinity of Pardeeville and down Fox River from that place. It is closely associated with Clyde soils and areas of Muck and Peat.

Description.—The Fox fine sand consists of a loose, light-brown fine sand to a depth of about 10 inches. It is free from gravel and stones, and its organic-matter content is low. The subsoil consists of a yellow fine sand. The material is loose and becomes lighter in color with depth. Lenses and beds of gravel occur in places in the subsoil. Low-lying areas are dark in color.

Topography and drainage.—The topography is level except where the sand has been blown into low dunes. These, however, are usually absent from areas of this soil.

The open texture of the subsoil insures thorough drainage, notwithstanding the level topography. In places the subdrainage is so complete that crops suffer from drought.

Origin.—The type is derived from the weathering of glacial outwash sands. The lenses and beds of gravel present contain considerable limestone. By the litmus paper test the soil is acid.

Native vegetation.—The original forest growth consisted largely of oaks, with softwood trees in low, moist places.

Present agricultural development.—By far the larger part of the area is under cultivation, being utilized for the growth of the general farm crops. Average yields are somewhat lower than those obtained on Fox fine sandy loam. This soil may be classed as having fair agricultural value.

BOONE SAND

Extent and distribution.—The type is confined to the northwestern part of the county, where it is associated with the Knox silt loam, occupying the lower slopes, bordering the Wisconsin River valley. It is of very limited extent, occupying only about 1 square mile. The type occurs on steep slopes, and is often badly eroded.

Description.—The surface soil of the Boone sand consists of a gray or grayish-brown fine sand about 8 inches deep, somewhat darker over the lower slopes, due to accumulations of organic matter. The subsoil consists of a light-yellow fine sand, becoming slightly darker with depth. In some places a reddish tinge is noted below 20 inches, and the deep subsoil is frequently mottled with red iron stains. In some places the underlying Potsdam sandstone is within reach of the auger and often outcrops.

Topography and drainage.—The type occurs on steep slopes and is often badly eroded. Owing to the sandy nature of the soil and its topographic condition, the natural drainage is excessive.

Origin.—The material composing this type has been derived from the weathering and disintegrating of the Potsdam sandstone.

Native vegetation.—The forest growth consisted of pine, fir, spruce, oak, and hickory. A large part of the type is still forested, though most of the valuable wood has been removed.

Present agricultural development.—With the exception of a few small gardens in the northern part of Kilbourn, the type has not been used for growing crops, but is mainly in pasture.

GENESEE FINE SAND

Extent and distribution.—This type is confined chiefly to the valley of the Wisconsin River, where it occupies islands and low sand flats bordering the stream. All such areas are subject to overflow. An area several square miles in extent is found due west of Portage, with other tracts to the south on both sides of the river. The type is of minor importance, occupying in all only about 8 square miles.

Description.—The surface soil of the Genesee fine sand consists of a loose, grayish to light-brown fine sand about 8 inches deep, containing only a small amount of organic matter. The subsoil is a yellowish fine sand of the same texture and structure as the soil and considerably more than 3 feet in depth.

The type is subject to considerable variation in color, texture, and depth. The surface soil has been wind blown in places into low

dunes. On the crest of such dunes the soil is light, while in the depressions and old sloughs the material is loamy and darker colored, owing to the accumulation of organic matter in varying amounts. Small areas of peat, silt, sand, and gravel are encountered, although none of these variations are large enough to be indicated on the soil map.

Topography and drainage.—The topography is level, except for the undulations caused by wind action and some old stream channels which cut across the type in a number of places. The surface is low, subject to annual overflow and usually wet during the spring and early summer months. During dry spells when the river is low the soil is well drained.

Origin.—The material forming this soil is of alluvial origin, modified somewhat by wind action. The parent rock is the Potsdam sandstone, although in many places this has been influenced by glacial action. The soil of this type is usually in a slightly acid condition.

Native vegetation.—The forest growth consisted chiefly of swamp oak, sycamore, basswood and willow, with some ash and elm. The best of this growth has been cut, but there is still a fair stand of trees and considerable undergrowth over most of the type.

Present agricultural development.—All of the type is subject to overflow. Some of it lies between the levee and the river, though most of it occurs where no levees have been constructed. Little attempt at improvement has been made for this reason. Aside from the marsh hay, which can be cut from a portion of the type, and the pasture which it affords, it has but little present agricultural value.

GENESEE SAND

Extent and distribution.—This type is of limited extent and confined to the Wisconsin River valley. One area occurs about 5 miles west of Portage, while another is found 7 miles to the south, on the east side of the river.

Description.—The surface soil of the Genesee sand consists of a loose, sand about 8 inches deep, varying in color from a light brown to gray or pale yellow, according to moisture conditions and organic-matter content. The subsoil is a light-yellow, loose, medium sand extending to a depth of 3 feet or more and frequently carrying lenses of coarse sand and gravel. The type is very similar in texture to the Plainfield sand, but differs from that type in that it lies within the present flood plain and is subject to annual overflow.

Topography and drainage.—The topography is level, except where broken by undulations due to wind action and depressions representing old sloughs. The type is low and subject to overflow. The water table is comparatively near the surface, but the soil becomes droughty during the dry summer months when the river is low.

Origin.—The material forming the Genesee sand is all of alluvial origin and has been deposited by the Wisconsin River during times of high water. The parent rock contributing most largely to this material is the Potsdam sandstone, in most cases first influenced by glacial action.

Native vegetation.—The forest growth consists of swamp oak, willow, sycamore, elm, and ash. All of the best trees have been cut.

Present agricultural development.—The type is used principally as pasture, being very sandy. Protection from flood waters will be necessary before it can be devoted to cultivated crops.

If protected this type would be of the same value agriculturally as the low-lying phase of the Plainfield sand found along the Wisconsin River. It is doubtful if its extent and value would justify the construction of levees to prevent flooding.

CHEMICAL COMPOSITION AND IMPROVEMENT OF SANDS AND FINE SANDS

As is generally true with sandy soils the types of this group are deficient in all of the essential elements of plant food. This does not mean that they cannot be profitably farmed, but it does indicate that before satisfactory crops can be grown from year to year it will be necessary to build up the fertility of such soils. The sand types are found to be somewhat more deficient in the essential elements than are the fine sands and sandy loams, but because of the limited extent of the sand types they are all included in this one group. The supply of phosphorus in the fine sands will average about 800 pounds per acre, which is less than half the amount found in good, productive silt loam soils. The amount in the sand types is somewhat smaller. The amount of potassium present is also small and ranges from 15,000 to 25,000 pounds per acre in the surface 8 inches, this is about half the amount found in Miami silt loam. The supply of organic matter and nitrogen is small, the amount of nitrogen averaging about 1,500 pounds per acre. The soils of this group belonging to the Miami and Fox series are only very slightly acid, but the other soils of the group are usually acid, so that lime is a factor which should be considered in their improvement.

In order that the fertility of these soils may be increased it will be necessary to increase the supply of organic matter. This may be done by applying stable manure, peat, by growing legumes, or by green manuring, or by following a combination of these methods. One may well go to considerable expense and trouble in getting a good stand of clover, for when clover can be grown the fertility of a soil can be maintained and increased. To get clover started the use of lime and commercial fertilizers containing both potash and phosphorus may be necessary. Clover is not the only legume which can be used in building up the soil, but soy beans, yellow lupines, and cowpeas are also good soil improvers.

When the acidity is corrected by the use of ground limestone, or by some other form of lime, and a moderate amount of potash and phosphorus supplied it should be possible to get legumes started, which when plowed under will supply the needed organic matter. When a supply of active organic matter has thus been developed the need for applications of potash will largely disappear, though the need of phosphorus will doubtless continue. Most of these types are better adapted to growing potatoes or truck crops than they are to the production of general farm crops. A rotation consisting of clover, rye, and potatoes, where the second crop of clover is plowed under, usually gives good results on sandy soils. Potatoes, strawberries, cucumbers, melons, tomatoes, and the like could be profitably grown to a much greater extent than at present, especially in those sections where the shipping and marketing facilities are adequate.

CHAPTER VI

GROUP OF POORLY DRAINED SOILS

CLYDE SILT LOAM

Extent and distribution.—The Clyde silt loam is found associated with the Miami silt loam, deep phase, and to a lesser extent with the Carrington silt loam, deep phase. It covers approximately one-third of Columbus Township, in the southeastern part of the county. The type occurs throughout the eastern third of the county as long, narrow bands bordering stream courses. A well-developed area is found along the Baraboo River, to the south and west of Portage, while smaller tracts occur along Spring Creek between Lodi and the Wisconsin River and in various other parts of the survey.

Description.—The surface soil of the Clyde silt loam consists of a black or dark-brown smooth silt loam extending to an average depth of 14 inches and containing a large quantity of organic matter. The subsoil becomes lighter in color and heavier in texture with depth, until at 18 inches a drab silty clay loam showing a few yellow iron oxide stains is encountered. At 2 feet the subsoil approaches a clay loam and at 3 feet shows yellow or light drab, with iron stains.

Lenses of fine sand, crystalline boulders, and limestone fragments are frequently found throughout the soil section. Over limited areas the boulders are sufficiently numerous to interfere with cultivation. The variations which occur in the type, however, are of minor importance.

Topography and drainage.—The surface of this type is level to undulating, with a gentle slope toward the stream along which it occurs. In the larger areas there are a few old sloughs and abandoned stream channels, which produce a slight irregularity in the surface. On account of its low position, even surface, and the heavy character of the soil the natural drainage is very defective, and the establishment of drainage systems is essential before the type can be successfully used for the growing of cultivated crops. Very little of this type is subject to overflow, but it occupies low situations and is generally wet, especially in the spring and early summer.

Origin.—The type represents old ponded valleys, lake beds, and other shallow depressions due to the uneven distribution of glacial

till, and the soil is in part of alluvial origin. Its low position and moist condition have favored the accumulation of organic matter, which has imparted a dark color to the soil. As the type is derived partly from calcareous drift, it is rarely acid.

Native vegetation.—The original forest growth consisted chiefly of elm, ash, soft maple, willows, and other moisture-loving trees and shrubs. There is still considerable timber standing.

Present agricultural development.—Comparatively few areas of the Clyde silt loam are under cultivation, but wherever adequate drainage has been provided excellent crops are being grown. Corn yields an average of 50 bushels per acre, while yields of 80 bushels are often reported. Grass makes a rank growth, and timothy hay yields 1½ to 2 tons per acre. Alsike clover does well. Small grain is apt to lodge, but yields of 25 to 40 bushels per acre are obtained. The quality is inferior to that raised on the Miami soils. Peas are grown to a limited extent, but run too much to vine to give the best results. Sugar beets yield from 12 to 18 tons per acre, but the sugar content is lower than from beets raised on the lighter-colored upland types. Cabbage also does well on this type.

The most common system of cropping consists of hay for one or two years, after which the sod is plowed for corn, sometimes being manured first, and followed a second year by the same crop. A small grain is usually sown after the second corn crop and the field again seeded to timothy or a mixture of timothy and alsike.

Where drainage is well established and the soil worked under favorable moisture conditions but little difficulty is experienced in securing a good seed bed. The soil is rather heavy, however, and if worked when too wet or too dry is apt to prove refractory. Considerable forest is still standing, and uncultivated areas are used for pasture.

The following table shows the average results of mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Clyde silt loam.

Description.	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Soil.....	0.0	0.2	0.8	6.1	8.8	63.9	19.9
Subsoil.....	.0	.3	.8	4.1	7.7	73.9	13.1

CLYDE LOAM

Extent and distribution.—The Clyde loam in Columbia County is of very limited extent and does not cover more than 3 or 4 square miles. It is seldom that an area of more than 160 acres is found and most tracts are much smaller. It is fairly well distributed throughout those portions of the county where the upland consist of soils of the Miami series.

Description.—The surface soil to an average depth of 10 inches consists of a black loam or light textured silt loam, containing a large amount of organic matter; a few inches of peat or muck may cover the surface. The subsoil is a drab, bluish, yellowish, or mottled material, variable in texture, though usually being a loam or heavier. Coarse sand or fine gravel often gives the subsoil a gritty characteristic.

Topography and drainage.—The surface is level to very gently sloping, and on account of the low position the natural drainage is poor. The subsoil is of such a character as to permit tile drains to draw for a long distance when properly installed.

Origin.—The material composing this soil is partly alluvial and partly lacustrine. It occupies the beds of old lakes and ponds and sometimes it occurs as narrow strips of low land along stream courses. The gritty material in the subsoil is largely limestone and, while the surface soil may be slightly acid in places, the subsoil is usually quite calcareous.

Native vegetation.—The original timber growth consisted of elm, ash, sycamore, willow, and a few other water-loving trees. In some places a heavy growth of grass was found where the tree growth was sparse.

Present agricultural development.—Only a small percentage of the Clyde loam is improved and under cultivation at present where well drained excellent crops of corn, hay, and small grain are secured. Small grains are apt to lodge and the quality is not equal to grain grown on Miami silt loam. Sugar beets can be profitably grown but the acreage on this type is very small.

CHEMICAL COMPOSITION AND IMPROVEMENT OF CLYDE SILT LOAM
AND CLYDE LOAM

These two types of soil occupy a combined area of about 26,000 acres or a little over 5 per cent of the county. They are important, not because of their present state of development, but because of their possibilities for future development. They are low lying, and

at present poorly drained, but with the establishing of proper drainage systems, which in most cases could be installed at a comparatively low cost, they can be developed into highly productive soils.

Since these soils are formed along the border line between upland light colored soils and peaty and muck marsh soils, they are intermediate in chemical composition between these two extremes. Moreover, their position is such that they have received a considerable deposition of fine silt from the higher land with its larger content of plant food. These soils have in the surface 8 inches approximately 2,000 pounds of phosphorus per acre; from 30,000 to 40,000 pounds of potassium; and approximately 10,000 pounds of nitrogen. Since they are surrounded by highland, the subsoils of which are rich in ground limestone which is being continuously dissolved and carried to the lower lands by percolating waters, they are as a rule not acid, and in fact usually contain considerable quantities of lime carbonate.

In spite of their large content of both phosphorus and potassium, it is not infrequently true that these soils show low availability of these elements, especially of potassium. This is probably due to the inert condition of much of the organic matter which protects the earthy part of the soil. Where thoroughly good artificial drainage has been developed and nevertheless poor crops secured, this result will usually be found to be due to lack of available potassium and in some cases also of phosphorus. A direct experiment should be made in these cases with potassium and phosphate fertilizers, as suggested in the bulletins of the Experiment Stations.*

The most important question in the improvement and management of these soils is one of drainage. Practically all areas are in need of drainage, and tile drains will be found most practical in the majority of cases. When properly drained and well managed, very satisfactory yields can be secured. Cabbage, onions, and sugar beets are some special crops which can be successfully raised on these soils, aside from the general farm crops, such as timothy, alsike clover, corn, and small grain. Grain crops usually make a rank growth but are apt to lodge. Stable manure should not be applied to these soils as the nitrogen is not needed. The mineral elements, where needed, may be supplied in the form of commercial fertilizers, as indicated above.

*For more information write to Wisconsin Experiment Station for bulletins on drainage and fertilization of low, poorly drained tracts of land.

For special information on drainage, see Bulletin No. 229 of the Wisconsin Experiment Station.

CLYDE FINE SANDY LOAM

Extent and distribution.—This type is of comparatively small extent and is found in the lowlands associated with other soils of the Clyde series. In all about 24 square miles were mapped. The type occurs in small areas in many parts of the county. These are most numerous in Otsago and Fountain Prairie Townships.

Description.—The surface soil of the Clyde fine sandy loam consists of a loose and open fine black sand to fine sandy loam, 12 inches deep, containing considerable organic matter. The subsoil is a dark-drab fine sand, becoming lighter with depth, and grading at about 18 inches into a sticky fine sand or a light sandy clay. The texture then becomes heavier, and at 2 feet a sandy clay is encountered.

The type is subject to considerable variation, though as a whole it conforms more closely to a fine sandy loam than to any other type. The surface is frequently covered with 2 to 3 inches of Peat or Muck, which becomes incorporated with the soil as soon as the type is put under cultivation. Areas of limited extent often have a surface covering approaching a loam in texture, though where this is found the type is always shallow and underlain by fine sand.

Topography and drainage.—The topography is level, the low position of the type and the proximity of the water table to the surface making natural drainage poor.

Origin.—The type is derived from the deposition by stream action of the fine sand and other material washed from the adjoining higher-lying land. Accumulations of organic matter, favored by abundant moisture and decaying vegetation, have imparted a darker color to the soil. Being associated with glaciated limestone soils and having been derived from this source, the material contains varying amounts of lime carbonate. The surface is seldom acid and the subsoil is usually calcareous.

Native vegetation.—The original forest growth consisted of swamp oak, willows, elm, sycamore, quaking aspen, and sumac. Little valuable forest remains, though most of the type is still uncleared. Some marsh grasses are also found.

Present agricultural development.—Not over 10 per cent of this type is under cultivation, although where open ditches have been constructed and the land drained, yields of 30 bushels of corn, 25 bushels of oats, 20 bushels of buckwheat, 100 bushels of potatoes, and about 1½ tons of timothy and clover hay to the acre have been secured. Little, if any, attempt has been made to specialize on this

soil, and rotations best suited to local conditions have not been worked out.

CLYDE FINE SAND

The type is inextensive and of minor importance, occupying a total area of 1 square mile. It is associated chiefly with the Clyde fine sandy loam. One small area lies immediately east of Pardeeville, with another about 5 miles to the east, and smaller patches in other parts of the county.

Clyde fine sand consists of a fine black sand about 12 inches deep, containing a large amount of organic matter and underlain by a loose, drab, fine sand, showing mottlings of yellow in the lower part of the soil section. Variations from the typical soil occur over limited areas, but are not important enough to show on the map.

The surface of the type is low and flat, and on account of its position and the proximity of the water table to the surface the natural drainage is poor.

The material composing the type has been washed from the higher lands adjoining the Miami soils and deposited in low places. The darker color is caused by accumulations of organic matter resulting from the partial decay of vegetation in the presence of moisture.

The native vegetation consists principally of grasses and sedges, with a few willows.

Only a very small part of the type is cultivated, but where properly drained fair crops can be secured. It is adapted to about the same crops as the Clyde fine sandy loam and requires similar treatment.

DUNNING LOAM

Extent and distribution.—The type is of small extent, occupying less than 8 square miles in the county. It occurs principally in Fort Winnebago and Lewiston Townships. The type is associated with the Coloma soils.

Description.—The Dunning loam consists of about 12 inches of black loam containing considerable silt and organic matter and underlain at a depth of about 20 inches by a drab clay loam, mottled with yellow and containing lenses of fine sand. This material becomes heavier and the mottling more pronounced at depths ranging from 20 to 36 inches.

The type is subject to considerable variation. In places the subsoil is a drab loam grading into a sandy clay loam, underlain at 2 feet or more by a sticky fine sand, becoming loose in the lower por-

tion. In places from 5 to 6 inches of fine sand may be found immediately underlying the surface soil. A covering of 4 to 5 inches of peat is found over a few small areas, the subsoil being a mixture of sand and clay. None of the phases were of sufficient extent to map separately.

Topography and drainage.—The topography is level, which, with the low position of the type, makes the natural drainage poor. The water table is usually within a few feet of the surface, and during the spring the soil is almost completely saturated. At times portions of the type are several inches under water.

Origin.—This soil is similar in origin to that of the Clyde silt loam. It occupies low, flat areas and depressions representing old lake beds or swamps and ponded valleys, and contains some alluvial material along present streams. The dark color is due to the accumulation of organic matter resulting from decaying vegetation in the presence of moisture. The parent material was largely from sandstone and the soil and subsoil are acid, thus differing from the Clyde soils which are usually not acid.

Native vegetation.—The original forest growth consisted chiefly of willow, quaking aspen, swamp oak, and other water-loving trees, shrubs and grasses. Nearly all the trees have been removed, only a scant growth remaining over the type.

Present agricultural development.—Where properly drained the type is suited to a number of general farm crops. Most of it, however, is unimproved and in its present undrained condition is of value chiefly for the pasture it affords, and the marsh hay which can be cut.

DUNNING FINE SANDY LOAM

Extent and distribution.—The Dunning fine sandy loam is a type of minor importance in Columbia County, occupying a total area of less than 5 square miles. The largest tract is found occupying the low ground at Portage. The next largest area occurs along the Wisconsin River in Newport and Lewiston Townships. Other smaller tracts are scattered throughout the northwestern part of the county. The type is confined chiefly to those regions where the upland soils belong to the Coloma and Plainfield series.

Description.—The surface soil to an average depth of about 8 inches consists of a dark brown to black fine sandy loam, over which there may be a few inches of peat or muck. The subsoil usually consists of a gray, drab, or mottled fine sand, which at 18 to 24 inches grades into a sticky fine sandy loam. In a few places a sandy clay

was found at about 3 feet. The subsoil is quite variable, but because of its limited extent no phases were mapped.

Topography and drainage.—The surface is level or only very gently sloping, and because of its low position the natural drainage is poor. The water table is usually within 3 feet of the surface and for portions of the year parts of the type may be covered with a few inches of water. Open ditches have been constructed in a few places.

Origin.—This type is of similar origin to the Clyde fine sandy loam, being in part alluvial and part lacustrine. The parent material came largely from glaciated sandstone debris. Practically all of the type is acid and this is the chief point of difference between it and the Clyde soils.

Native vegetation.—Where timbered the original growth consisted of a sparse growth of willow, elm, ash, and a few water-loving shrubs. A considerable portion of the type was treeless and supported a heavy growth of coarse marsh grass.

Present agricultural development.—Only a very small proportion of this type is sufficiently well drained to permit growing cultivated crops. Where drained the general farm crops common to the region are grown and fair yields obtained. Most of the type is unimproved and undrained. Over some undrained tracts marsh hay can be cut, and grazing is afforded in some places.

CHEMICAL COMPOSITION AND IMPROVEMENT OF CLYDE FINE SANDY LOAM, CLYDE FINE SAND, DUNNING LOAM, AND DUNNING FINE SANDY LOAM

These soils are quite uniform in their content of mineral plant food elements, and nitrogen, but because of their sandy nature they contain relatively lower amounts of phosphorus and potassium than do the heavier Clyde soils. The total phosphorus averages about 1,000 pounds, in the surface 8 inches per acre, while the supply of potassium is about 25,000 to 30,000 pounds, and the amount of nitrogen approximately 5,000 pounds. These soils are quite variable in their content of lime. The Clyde soils occur in regions where limestone material has entered largely into the formation of the soils, and these types are seldom acid, or only slightly so at the surface, while the Dunning soils occur in regions where no limestone has entered into the formation of the soils, and the types are always found to be acid.

The first step in the improvement of these soils is drainage. When this has been thoroughly established they will usually require the

use of commercial fertilizers containing potassium and phosphorus. In nearly all cases there is a sufficient amount of nitrogen, so that the stable manure can be applied to the upland to better advantage than to these low lying soils. Where the soils are acid the use of ground limestone to correct this condition will be found profitable.

CHAPTER VII

MARSH SOILS

PEAT

Extent and distribution.—Peat soils make up a total of 10 per cent of Columbia County.

Extensive areas of Peat are found in the lowlands in the vicinity of Portage, along the Wisconsin and Fox Rivers, in Pacific and Fort Winnebago Townships. Other large areas lie along Duck Creek, between the Wisconsin River and Cambria, and in Lewiston and Newport Townships, while smaller patches occur in nearly all parts of the county, except in the prairie regions and the hilly section of Caledonia Township.

Description.—The material mapped as Peat consists of black or dark-brown vegetable matter in varying stages of decomposition, with which there has been incorporated a small amount of mineral matter. This varies in depth from 2 to 20 feet, with an average of $3\frac{1}{2}$ to 4 feet. The upper portion of the peat beds is usually quite fibrous, the material becoming more thoroughly decomposed with depth, forming in the lower portion a soft mass which is sufficiently tenacious to be molded into different forms by the hand. When dry this decomposed Peat somewhat resembles a black carbonaceous clay. Where encountered in areas of sandy soils the underlying material is frequently sandy, while in the region of heavy upland soils the underlying material is clayey.

Topography and drainage.—The peat beds occupy low, flat areas, and on account of their position and the fact that the water table is so close to the surface the natural drainage is very poor.

Origin.—The Peat has been formed through the growth and partial decomposition in the presence of water of a rank vegetation, the black or dark-colored material being formed largely from grasses and sedges, while that having a brown color was formed chiefly from sphagnum moss. About the margin of the larger marshes and over the greater part of many of the smaller ones varying quantities of soil from the adjoining higher land have been washed in and incorporated with the vegetable matter. Wherever this has been sufficient to materially change the texture and structure of the material it has been separated and mapped as Muck.

The peat beds occupy old lake basins, ponded valleys, kettle basins, glacial sloughs, and other depressions in the uneven surface developed by the ice sheet. Peat may also be found within the flood plain of many of the present streams.

Many of the peat marshes are in an acid condition, especially those in the region where the upland soils contain little or no lime carbonates.

Native vegetation.—The native growth over Peat is confined to several varieties of grasses, sedges, and some arrowhead, cattail, and various reeds and rushes. On the sphagnum-moss peat beds are found tamarack, sumac, huckleberry, and quaking aspen. Where the Peat is shallow elm and ash are sometimes found.

Present agricultural development.—In Columbia County scarcely any of the Peat has been improved beyond ditching in order that marsh hay may be secured. On a large number of farms the peat marshes are the chief source of hay, and in many cases they are used as pastures. The hay is cut from early in July to early in September. One ton per acre is about the average yield.

MUCK

Extent and distribution.—The Muck is not nearly as extensive as Peat, the largest tract being found along the headwaters of the Fox River, northeast of Pardeeville. The type is confined largely to the eastern part of the county. It occupies low, flat areas in old lake beds, kettle basins, stream channels, and ponded valleys, all of which abound in this glacial region.

Description.—The material mapped as Muck consists of partially decomposed vegetable matter, with which there has been incorporated a considerable quantity of mineral matter. The Muck is black or nearly black and extends to a depth of 8 to 24 inches. The underlying material consists for the most part of a drab or grayish fine sand. Variations in the type are numerous, though comparatively inextensive. The most common of these is where the sand or silt from the upland has been washed down and deposited over a peat bed, thus developing a phase of Muck having a high content of mineral matter near the surface, but underlain by Peat. In places small peat beds have been drained for a long period, allowing the surface soil to decompose in the atmosphere, bringing about a concentration of the mineral matter of the Peat and producing a black Muck, containing some fine sand underlain by Peat, which becomes comparatively pure with depth. The surface of such muck beds when dry and under cultivation is subjected more or less to wind

erosion. In a few places the material underlying the Muck is a clay or silty clay.

Topography and drainage.—The surface of the Muck is level, or only very gently sloping, and because of its low position and the nearness of the water table to the surface, the natural drainage is poor.

Origin.—The origin of the largest muck beds in the area is identical with that of the Peat, except that in general the Muck has been exposed to the atmosphere, has undergone a more thorough decomposition, and has a much higher mineral-matter content.

Litmus tests indicate that a part of the type is in an acid condition.

Native vegetation.—The vegetation of the muck beds consists of willows, quaking aspen, sumac, ash, swamp oak, and various wild grasses. Where the grasses abound there is usually no other growth, except a few scattered willows.

Present agricultural development.—Except for the production of marsh hay, this type has been improved only to a limited extent. A small amount of drainage work has been done, including the construction of a few open ditches, but the greater part of the Muck is still undrained. Where drained and properly cultivated satisfactory yields of corn, oats, onions, cabbage, and a number of other crops can be secured.

CHEMICAL COMPOSITION AND IMPROVEMENT OF MARSH SOILS

Approximately 12 per cent of Columbia County consists of Peat and Muck soils, about 10 per cent being Peat and 2 per cent Muck. Only a very small amount of this marsh land has been improved, but since the greater proportion of it can be drained and successfully farmed its reclamation is of great economic importance.

Peat has been largely formed by the accumulation of vegetable matter, particularly sphagnum moss and certain sedges and grasses. It is low in earthy matter, often running from 80 to 95 per cent of organic matter, though whenever it contains over 50 per cent of organic matter it can be justly classed as Peat. In Muck the amount of organic matter falls below 50 per cent, and there is a correspondingly larger amount of mineral matter. This is the chief point of difference between Peat and Muck. As the amount of earthy matter in the Peat is low the supply of mineral plant food elements is also small, the total weight of phosphorus being approximately 600 pounds per acre to a depth of 8 inches, and of potassium, about 700 pounds. In Muck these amounts are somewhat higher.

It will be seen, on comparison of these statements with those made on the composition of such soils as Miami silt loam and Fox silt loam, that the total amount of potassium, in particular, is extremely small, the amount in Peat often being less than 2 per cent of that found in the upland silt loam soils. While the total amount is small, a large proportion of it is available to plants, especially if the surface has been burnt over, and the supply may be sufficient for from 1 to 3 crops. It is to be expected, therefore, that profitable cropping is possible over a long period of years, only by the use of some form of potassium fertilizer, either barnyard manure, wood ashes, or the usual commercial fertilizers containing this element. The total supply of phosphorus is rather low, though the difference between the amounts present in Peat and upland soils is very much less than in the case of potassium. In view of the enormous quantity of nitrogen contained in Peat, the average amount of which is over 15,000 pounds per acre 8 inches, it is unnecessary to use stable manure, the most valuable element of which is the nitrogen, so that, on farms including both Peat or Muck land and upland soils, the stable manure should be used on the upland, and commercial fertilizers containing phosphorus and potash, if needed, on the lower land, unless, indeed, there is sufficient manure for the entire farm, which is rarely the case. These marsh soils are rarely acid throughout the limestone regions, on account of the percolation of lime-containing water from higher lands, though occasionally patches of acid Peat are found on the larger marshes. Where there is no limestone material in the upland soils, as is the case in the northwestern portion of the survey, the marsh soils are acid. This acidity, however, is not so detrimental in the case of marsh lands as in the case of sand and clay soils, since the chief objection to acidity is that it interferes with the growth of those legumes, such as clover and alfalfa, which are needed on the higher lands to secure nitrogen, but which are not needed on the marsh soils for this purpose, and to the growth of which, indeed, the marsh soils are not so well adapted physically.

In the improvement of Peat the question of drainage* is the first step to be considered. Both open ditches and tile drains can be utilized in reclaiming the marshy tracts.

When properly handled Peat and Muck will produce profitable crops of corn, alsike clover, timothy, small grains, and other general farm crops, as well as special crops such as peppermint, celery, etc.

*For special information concerning drainage and the improvement of marsh soils, write the Soils Department of the Wisconsin Experiment Station.

ROUGH STONY LAND

The areas mapped as Rough stony land consist of steep, rocky slopes, upon which the covering of soil is very thin and where rock fragments and outcrops are numerous. The soil on these slopes is usually a fine sand, which in the absence of the rocks could be mapped as Boone fine sand. The type is confined to the southwestern part of the county, where it occurs as long, narrow bands along the steepest hill slopes. In a few instances it extends over the tops of hills.

Because of the steepness of the slope and the sandy nature of the soil, the natural drainage is excessive and the vegetation suffers from lack of moisture.

The sandy soil has been derived from the weathering and disintegration of the Potsdam sandstone, which forms the walls of the old preglacial valleys on the slopes of which the Rough stony land is found. Most of the outcrops are also Potsdam sandstone, although a few of the hills are capped with Lower Magnesian limestone. Limestone fragments are sometimes mixed with the sandstone.

Where a forest growth occurs on these slopes it is usually scrubby oak or hickory. Many of the steeper slopes are bare except for some grass.

The Rough stony land is a nonagricultural type and of value only for the small amount of pasture which it affords. Its only other possible use is for forestry, and it is doubtful if this could be made successful, because of the shallow, droughty nature of the soil.

CHAPTER VIII

GENERAL AGRICULTURE OF COLUMBIA COUNTY

Agriculture in Columbia County dates back to 1836. The pioneers, accustomed to the forested lands of the East, were not favorably impressed with the long stretches of open prairie, and started their farming operations in the timbered regions or in the openings, where they thought the soil would be more productive than on the prairies. Later the prairies were also put under cultivation with very good results. Settlement of the county was quite rapid and portions of it early became agricultural regions of importance. Grain crops, including wheat, oats, barley, rye, and flax, constituted the larger part of the farm products for a number of years, wheat being the most important.

The severity of the winters on the open prairies caused the early settlers to plant their winter wheat in the clearings and the spring wheat on the prairies. Continued cropping under this system with no effort on the part of the owners to maintain the soil by the use of fertilizer caused yields to decline to a point where wheat was no longer profitable. The chinch bug also appeared and wheat farming gradually gave way to a more diversified system of agriculture. Corn and oats came to be more important, and stock raising, stock feeding, and dairying gradually developed. Potatoes were early found to be adapted to the sandy soils and soon became an important crop. Barley production also increased to considerable proportions. Tobacco was introduced in Dane and Rock counties in 1858, and this crop soon spread to the surrounding regions, including Columbia County. The yields were excellent and the crop sold for cash. The tobacco grower became a stock feeder rather than a dairy farmer, and larger numbers of sheep and cattle were raised on the farms which produced the tobacco. When the natural meadows became inadequate to supply pasture tame grasses were seeded on the uplands. Continued cropping was the common practice, and it is only within about the last 20 years that any careful attention has been given to crop rotation. General farming is the prevailing type of agriculture in the county, supplemented in some sections by dairying, the production of special crops, or stock raising, depending upon local conditions.

The general farm crops of the region consist of corn, oats, barley, wheat, rye, clover, timothy, buckwheat, and some alfalfa. The corn crop of 1909 from 58,957 acres amounted to 2,014,287 bushels, or an average of about 34 bushels per acre. White and yellow dent corn are the types generally grown, although some farmers prefer the flint. Several improved varieties are being introduced by the Wisconsin Experiment Station, with marked improvement in the quality of seed and gradually increasing yields. The corn is usually cut with a harvester and husked from the shock, the stalks being shredded or stacked for winter feed. The silo is coming into more common use, and considerable corn is now being preserved in the form of ensilage for winter feed. Corn is grown in all parts of the county, but the acreage is greater and the yields are larger in the prairie regions and on the Miami silt loam, deep phase, than over the sandy portions of the county.

The oat crop is also important, the acreage frequently exceeding that devoted to corn. In 1909 the crop from 59,695 acres amounted to 1,864,154 bushels, or an average of 31 bushels per acre. Comparatively little of the crop is sold, most of it being fed to stock on the farms. Swedish Select, New Kherson, and Big Four are among the varieties most extensively grown. The best oats are grown on the Miami silt loam, deep phase, though larger yields are often obtained upon the black prairie soils.

Barley is still an important cash crop, though the acreage is considerably below that of corn and oats. The crop of 1909 from 16,102 acres amounted to 438,827 bushels, or an average of about 27 bushels per acre. At present the acreage is decreasing, due to a decline in yields as the result of continued cropping, as was the case with wheat. On the heavy soils of the area barley gives very satisfactory yields when grown in rotation with other crops.

Wheat is being grown to a slightly greater extent at present than was the case a few years ago, although the acreage is still very small. The crop of 1909 from a total of only 1,970 acres amounted to 36,234 bushels, or an average of about 18 bushels per acre. Of this approximately one-fourth was winter wheat. The yields from this variety exceeded the spring wheat by nearly 4 bushels per acre. Danger of winter killing is given as the reason for the larger acreage of the spring wheat.

Rye is grown chiefly in the sandy portions of the county. It is produced as a grain crop, for green manuring, and for pasture. When the rainfall is sufficient fair crops are secured, though the average yield is low. The crop of 1909 from 11,255 acres was 141,199 bushels, or about $12\frac{1}{2}$ bushels per acre. When used for

green manuring the rye is usually sown on corn or potato land and plowed under the following spring. It may be pastured in the fall and early spring.

Timothy and red clover are the most common of the grasses and clovers used for hay and pasture. Considerable difficulty has been experienced during the past few years in securing a good stand of clover, due in part to winter killing during the late winter when the snow is melting and the ground freezing and thawing alternately, and partly to the hot, dry weather during the late summer. An acid condition of the soil is not favorable for the best development of legumes, including the clovers. The sourness of the soil weakens the development of the clover plant and makes it more susceptible to frost and drought. During the progress of the survey frequent litmus tests were made, and it was found that soil acidity was quite prevalent in varying degrees over different soil types. On the heavier soils alsike clover is being grown to a considerable extent. Mammoth clover is used for pasture and also for hay on the lighter soils, but on the heavier types it becomes coarse and is not as satisfactory as the medium red clover. Timothy is being seeded by itself to some extent and cut for seed as well as for hay. Over the marshy parts of the area many tons of marsh hay are cut every year, furnishing an abundance of feed of inferior quality.

Alfalfa is being grown to a limited extent throughout the county. At least three cuttings can be secured, 3 tons per acre being about the average yield per year. This crop has passed beyond the experimental stage and can be grown successfully wherever the soil is kept in the proper condition. Liming is often necessary, and to insure a good stand the field should be inoculated and also well supplied with stable manure.

Some buckwheat is grown, but the crop is of minor importance. Only 577 acres were planted in 1909, from which 7,546 bushels were harvested, averaging about 12 bushels per acre. It is grown chiefly in the low, sandy portions of the county.

Aside from the general farm crops common to this region, a number of special crops have been found well adapted to the soils of the area, and which have added materially to the profits of farming. Chief among these crops grown at present are potatoes, tobacco, beans, peas, and sugar beets. The acreage of most of the special crops raised could be profitably extended.

The potato is the most extensively grown of the special crops, the annual output for the county in 1909 from 7,098 acres amounting to 1,350,775 bushels, or an average of about 181 bushels per acre. The crop is confined largely to the sandy soils of the area, to which it

is well suited. Yields are satisfactory as a rule and the tubers of good quality. A large part of the crop is sold soon after digging, although a number of warehouses have been constructed and some potatoes held for the late winter market. Some farmers store their own crop in cellars or pits and place them on the market in the spring. The most progressive farmers use modern machinery in planting, cultivating, and harvesting the crop. The Early Ohio is the most popular of the early varieties, while the Rural New Yorker, and Peerless are preferred as the later varieties.

Columbia County ranks fourth among the counties of the State in tobacco production. In 1905 the crop amounted to 3,142,475 pounds. Most of the tobacco grown is of the Comstock Spanish variety. About 85 per cent of the crop is sold as binder tobacco and the remainder, consisting of broken leaves and stems, as filler. The average yield is about 1,100 pounds per acre. Binder tobacco commands prices ranging from 6 to 14 cents per pound and filler about 2 cents per pound. The crop is usually contracted for in the fields to be delivered after curing, the contract price depending upon the condition at time of delivery. An average price of 10 cents per pound is considered necessary to make the crop a profitable one. Tobacco is grown most extensively on the silt loam and fine sandy loam types. Because of the uncertainty of the crop and prices and owing to the labor required the acreage is being reduced and many of the tobacco growers are engaged in the dairy industry. The crop is fertilized with stable manure, as nearly every tobacco grower is a stock feeder and hence has a supply of manure on hand. Applications range from 20 to 40 loads per acre, but in spite of this heavy fertilization yields are reported to be on the decline. Generally speaking, tobacco is grown on the same field year after year, receiving the greater part of the manure, and as a result the remainder of the farm suffers. Commercial fertilizers have been used to a limited extent, but are not in favor with the farmers. Most of the farmers produce their own tobacco seed, but too often fail to use care in its selection.

Beans have been found to be well adapted to some of the soils of the area, especially the silt loam and fine sandy loam types, there being at present about 5,000 acres planted each year to this crop. In 1908, 69,000 bushels were produced, representing a little more than half the total production of the whole State. Beans are grown on nearly every upland soil type in the county, but probably do best on the silt loam and fine sandy loam. Yields average from 16 to 20 bushels per acre, sometimes running as high as 28 or 30 bushels. Prices range from \$1.50 to \$2 per bushel. The common practice is

for the growers to sell their crop to seed houses for a definite price, the seed being furnished them and later deducted from the proceeds of the crop. The White Navy is the chief variety grown, though the Early Refuge and Brown Swede are also grown to some extent. Beans do best on a rich, friable soil and are most frequently planted after sod.

The growing of peas for canning purposes and for seed has developed into an important industry in some parts of the county. The four canning factories in the area are located at Columbus, Fall River, Randolph, and 2 miles north of Randolph. The Columbus plant is one of the largest of its kind in the country. In 1911 this factory handled the output from 1,500 acres, of which about two-thirds were grown in Columbia County. Yields range from 2,000 to 2,200 pounds per acre of shelled peas, the farmers receiving an average price of 2 cents per pound. To save long hauls, viners are located throughout the pea-growing districts, making possible the extension of the industry beyond the immediate locality of the factory. A large seed company has located a warehouse at Columbus for milling and cleaning peas, and they have built up an extensive business in handling seed peas. In 1911 they contracted for about 1,300 acres in the vicinity of Columbus. This same company is also using 50 acres in seed tests and stock-improvement work. The canning companies also contract for seed peas in districts too remote from factory and viners. Yields of seed peas range from 15 to 20 bushels per acre and the price obtained ranges from \$1.50 to \$2 per bushel. The varieties grown are the Alaska, a very early pea, and the Advance, Admiral, and Horsford, which mature later. The crop is planted to mature continuously throughout a considerable period. Peas are reported to be a very profitable crop. Being a legume, they tend to build up the soil in the same manner as clover and it has been noted that oats or barley yield heavier and produce grain of better quality after peas than following corn or other grain crops. During the season of 1911 the late peas were attacked by the pea louse, which did considerable damage. Early planting usually allows the crop to be harvested before this pest makes its appearance.

The Miami silt loam, deep phase, appears to be better adapted to pea growing than any other soil in the area. The crop does well on the Carrington silt loam, deep phase, but the quality is not as good as on the Miami silt loam, deep phase. When planted on Clyde soils the crop makes a rank growth of vine.

Sugar beets are grown to a considerable extent on the Carrington and the Miami silt loams. The farmers usually put in the crop and

attend to the horse cultivating, while the sugar-beet companies furnish laborers to do the handwork, such as weeding, thinning, and topping, making an acreage charge of approximately \$20 for this work. The crop is harvested and hauled to the shipping point by the farmer. Yields range from 10 to 18 tons per acre, for which a flat price is paid or settlement made according to test. The price averages about \$5.50 per ton. Tests are usually a little higher on the Miami than on the Carrington silt loam but the tonnage is usually higher from the latter soil.

Two salting stations have been established in the county to handle the cucumber crop, the growing of which has come to be quite an important industry on some of the sandy types of the area. About 15,000 bushels were harvested in 1911. A large pickling concern furnishes the seed and contracts for the entire crop. The cucumbers are planted in hills about $1\frac{1}{2}$ feet apart, with 7 to 9 feet between the rows. Liberal applications of stable manure greatly increase the yields. The average yield per acre is 150 bushels. The cucumbers are graded according to size. Those under $3\frac{3}{4}$ inches bring 75 cents and larger ones 35 cents per bushel. The crop runs about 60 per cent small and 40 per cent large cucumbers. Because of the large amount of work required in gathering the crop, there is seldom more than an acre put in by any one farmer. The White Spine is the most common variety grown.

Cabbage is being grown most extensively in the vicinity of Cambria. About 150 acres were planted in 1911. This crop does best on a rich, moist soil, and it is therefore confined mainly to the heavier types. The Holland variety is most commonly grown. The plants are ordinarily set out with a transplanting machine similar to that used in setting tobacco plants. Frequent cultivation, with some handwork, is necessary. When the crop is harvested the outside leaves and stems are returned to the field. Cabbage is generally considered a paying crop, yields averaging from 10 to 15 tons per acre and the price ranging from \$4 to \$6 per ton. The cost of production is placed by some farmers at about \$2 per ton, though this is only a rough estimate. A large proportion of the crop is shipped to the wholesalers in the fall, but two warehouses have been built at Cambria for storing the crop for winter market.

Attempts have been made to grow cabbage on the same fields year after year, but cabbage rot soon appears, sometimes the second year, and this directs attention to the question of rotation. It is not advisable to take more than one crop of cabbage from a field during the rotation.

Considerable sorghum is grown on the sandy soils of the area, the quality being influenced to a certain extent by the texture of the soil. As this becomes heavier and the organic matter increases, the sirup becomes darker and less desirable. The output from the area in 1905 amounted to 3,746 gallons.

Trucking on a commercial scale has not been developed to any extent, though nearly every farmer has a garden in which most of the common vegetables are grown for home use. Near some of the towns small commercial truck gardens give good results. The sandy soils of the area are well adapted to a variety of truck crops, and where shipping facilities are adequate it would seem that this industry could well be extended.

Fruit growing has not been developed on a commercial scale to any appreciable extent. Apples do fairly well on many of the soils and there are a number of small home orchards scattered throughout the county. Cherries, raspberries, blackberries, currants, plums, grapes, and strawberries are grown to a limited extent, chiefly for home consumption. It would seem that most, if not all, of these fruits could be profitably grown to a greater extent than at present. Many of the slopes in Caledonia Township are well suited to apple orchards.

Dairying is an important industry, but should be developed to a much greater extent than it is at present. There are some purebred herds of Holsteins, Jerseys, and Guernseys, but the greater proportion of the dairy stock consists of grade animals, largely Holstein and Shorthorn. A number of the herds are headed by a purebred sire and in this way the stock is gradually being improved. In 1913 there were 13 creameries and 15 cheese factories in the county. Many of the farmers have cream-separators, hauling the cream to the creamery and feeding the skim milk to hogs on the farm. The dairy industry should be further developed. The silo is just beginning to be introduced, and with the extension of dairying the number should increase rapidly. Alfalfa should be grown on every farm in the county, as it furnishes an excellent feed and is a soil builder.

Beef cattle are fed quite extensively in the south-central and southwestern parts of the county. They are shipped in from northern and western points, fattened for the winter market, and sold after the holidays. The Shorthorns seem to be the most popular breed. In sections where feeding is carried on about 10 to 15 head per 100 acres are turned off every year.

Sheep are raised in nearly every section of the county and in the southern and western border districts, particularly in Caledonia Township, feeding for market is carried on quite extensively. West-

ern sheep are shipped in during the fall to points near Lodi, where they are pastured until winter sets in, and then housed and fed until ready for market.

Hog raising is quite general in all parts of the county, being carried on in conjunction with general farming and dairying. From 20 to 40 hogs are kept on the average farm, except on the lighter soils of the northern part of the county, where 10 to 20 is the average number. The Poland-China seems to be the favorite breed, though Berkshires, Duroc-Jerseys, and Chester Whites are also raised.

Horses are not raised to any extent in the county, though a number of the farmers plan to breed their working mares and raise enough work stock for their own farms.

It is generally recognized throughout the county that many of the crops grown are much better adapted to certain soil types than to others. Potatoes produce higher yields of better quality on the sandy types than on the heavier soils. Sugar beets do much better on the Miami and Carrington silt loams than on the sandy types. Peas appear to do best on the Miami silt loam, deep phase. Corn does well on the Carrington silt loam and the Clyde silt loam. On the latter type grains are apt to lodge and the quality is not as good as on the Miami soils. Cabbage requires a rich soil and is grown entirely on the Carrington and Miami silt loam. Although the adaptation of certain soils to particular crops is recognized, the present farming practices do not always permit the realization of plans best suited to prevailing conditions.

A common rotation on the heavier soils consists of corn one year followed by oats, barley, or wheat with which clover and timothy are seeded for two years. Hay is cut for one or two years and the field frequently pastured for one year before being again plowed for corn. On the lighter soils potatoes are grown one year and followed by grain (rye and oats) for two years and then seeded to clover and timothy. Frequent failures with clover have interrupted the rotations of many farmers, but the usual plan is to have grass on the land every 4 or 5 years. Attempts at continual cropping on the same field with such crops as cabbage, peas, and tobacco are still common, but the average farmer has learned that this is not a profitable system and is not conducive to continued fertility of the land or profitable yields.

In general, however, more attention is being paid each year to the selection of crop rotations best suited to local conditions and soil types throughout the county. Methods of cultivation, fertilization, seed selection, etc., are also being given more consideration, with the

result that agriculture is being placed upon a more scientific basis, with a tendency to adopt such practices as will maintain and increase the productivity of the soil.

Among the weed pests most common in Columbia County the Canada thistle, quack grass, and wild mustard are probably the most troublesome. The amount of damage caused by such pests is not fully appreciated, and all efforts looking to their eradication should be encouraged.

The buildings on the average farm in Columbia County are well constructed and substantial. Besides a frame or brick house, there is usually a barn with hay loft, a corn crib, shelter for cattle, hogs, and other stock, and where tobacco is grown, a large shed for curing this crop. The tobacco shed may also serve as a place for storing farm machinery. Although many farmers have their machinery kept under cover, there is room for improvement along this line.

Windmills are quite common, supplying water for stock and the home. Gasoline engines are being installed on many farms and used for pumping, grinding feed, sawing wood, churning, running washing machines, and sometimes an electric-lighting plant. Most of the fields are well fenced, many with barbed wire, though woven wire fencing is coming into more common use. Farm improvements vary in different sections of the county, being best on the Carrington and Miami silt loams and poorest on the sand and fine sand types.

An inadequate supply of farm labor often makes it necessary for the members of the family to do large proportions of the farm work. This condition frequently determines the type of farming practiced. On a monthly basis hands receive from \$30 to \$35, with board and washing included, and frequently the hired man's driving horse is cared for in addition. During haying and harvest time the day wage varies from \$1.50 to \$2. Wherever possible modern machinery is used, doing away with considerable manual labor.

The census of 1910 reported 3,327 farms in Columbia County, including 94.5 per cent of the total area of the survey. Of these 76.8 per cent are operated by the owners, and the remainder being nearly equally divided between share and cash tenants. The average size of farms is 141 acres, with an average of 92 acres improved. There are 585 farms which have 175 acres or more, 29 farms of 500 acres or more, and 3 farms which contain 1,000 acres or more. The value of farm lands varies greatly on the different types of soil. Much of the Miami and Carrington silt loam, deep phase, types is held at prices ranging from \$125 to \$150 an acre, while the poorest farms on the sand and fine sand types are worth only \$15 to \$25

an acre. Variations between these extremes depend upon location, character of the soil, and improvements.

While agriculture in the area as a whole is well developed, and while this area compares favorably with other parts of the State having the same soil conditions, there are, nevertheless, several lines along which further general improvements could be made. One great need of most of the soils of the area outside of the prairie regions and bottom lands is a larger supply of organic matter. This may be had by supplementing the stable manure with green manuring crops. Legumes are best for this purpose. Peat may also be used where bogs are convenient and no long hauls are necessary. The added organic matter will also increase the water-holding capacity of the soil. Nearly all of the soils are more or less acid, a condition which can be corrected by applications of ground limestone.

Crop rotations should be more carefully considered, with a view to securing combinations best suited to the various soils and increasing yields. The cultivation of intertilled crops could be improved by keeping a fine dust mulch on the surface during the growing season to conserve moisture and assist in carrying crops over dry periods, which are common, especially during late summer. Tests should be made to determine the value of commercial fertilizers in connection with the special crops which are grown in different parts of the county. This use of commercial fertilizers containing potash and phosphoric acid may be necessary in getting a good stand of clover on some of the sandy soils of the area.

There is a tendency in some parts of the county toward farming too large tracts. A number of farmers are working from 200 to 300 acres, where if only 80 to 100 acres were cultivated and care given every feature of the work the net returns would be greater.

The question of drainage should also receive attention. Thousands of acres of lowland in the county could be reclaimed at small cost and made to produce excellent crops. On many of the farms in the upland tile drains could be installed to advantage. Up to the present time comparatively little tile drainage work has been done in the county, but in view of the high land values the expense would be more than repaid by increased producing acreage and larger yields.

Cooperation among farmers in marketing their produce through a central agency would tend to secure larger and more uniform prices.

CHAPTER IX

CLIMATE*

"Among the factors which influence the agriculture of a state none is more important than climate. The class of crops which can be grown is largely determined by the length of the growing season, and the amount and distribution of the rainfall." Any one of these factors may determine the type of farming which can be followed to best advantage.

"The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation having a range of from 28 to 34 inches, while the mean for the state as a whole is 31 inches. This is a slightly heavier rainfall than is received by eastern England, northern France, most of Germany, Sweden, and the Dundee Valley. As compared with other portions of this country, Wisconsin has a total rainfall equaling that of central Oklahoma and Kansas, northern Iowa, Michigan, Northwestern New York, or the Puget Sound Basin of Washington. But owing to its northerly location, the lessened evaporation probably makes the precipitation as effective as that of Arkansas, Illinois, or Virginia."

The local distribution of rainfall varies, however, from year to year, some sections receiving more rain one year, and other sections more in other years. The variation is caused largely by the movement of cyclonic storms. The average rainfall for the entire State during the driest year was 21.4 inches, and for the wettest year 37 inches.

"Of equal importance, in agriculture, to the total rainfall, is its seasonal distribution, and in this respect Wisconsin is unusually fortunate, since about half of the total rainfall comes in May, June, July, and August, and nearly 70% from April to September, inclusive. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches and May 3.9 inches. The precipitation during the winter, on the other hand, is slight; December, January and February each averaging from 1 to 1.5 inches of rain and melted snow. The average rainfall for the state during winter is 3.9 inches, during spring 8.3 inches, during summer 11.4 inches and during

* This chapter has been taken largely from Wisconsin Bulletin 223 on The Climate of Wisconsin and its Relation to Agriculture. This bulletin should be consulted if more information is desired concerning climate. All quotations indicated are taken from this bulletin.

autumn 7.4 inches. Most of the rainfall occurs just preceding and during the period of plant growth, thus being received by the crop at the most effective time. Wisconsin receives during the growing season, April to September, inclusive, an average of 21 inches of precipitation, which is as much rain as that received during the same months by eastern Texas, Illinois, Ohio or eastern New York. The small winter precipitation in Wisconsin mostly in the form of snow, on the other hand, causes virtually no leaching of fertility from the soil, or erosion."

Another phase of rainfall distribution of great importance is its variation within a period of a few weeks. Frequently periods of drought and periods of unusually heavy rainfall occur, continuing for one to four weeks and occasionally longer. Observations taken at Madison by the Weather Bureau over a period of 30 years from 1882 to 1911, inclusive, show that there are on the average three ten-day periods during each growing season when the amount of rainfall is so slight that crops on a reasonably heavy soil (Miami silt loam) actually suffer from the lack of moisture. In Columbia County the conditions are practically the same.

The following table, compiled from the records of the Weather Bureau station at Portage, shows the normal monthly, seasonal, and annual temperature and precipitation for a period of years:

Normal monthly, seasonal, and annual temperature and precipitation at Portage.

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year	Total amount for the wettest year
	<i>°F.</i>	<i>°F.</i>	<i>°F.</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
December.....	21.2	53	—30	1.56	1.95	2.05
January.....	18.2	52	—28	1.15	2.04	1.23
February.....	17.4	53	—27	1.02	0.40	2.39
Winter.....	18.9			3.73	4.39	5.67
March.....	31.1	75	—7	1.81	0.44	2.30
April.....	46.3	89	12	2.81	1.65	2.96
May.....	58.7	95	25	4.01	2.26	7.13
Spring.....	45.3			8.63	4.35	12.39
June.....	66.7	102	31	4.11	0.82	9.98
July.....	71.4	106	44	3.35	2.05	1.79
August.....	68.7	97	43	3.23	2.80	3.17
Summer.....	68.9			10.69	5.67	14.94
September.....	61.3	92	25	2.83	1.65	3.90
October.....	50.0	85	13	2.13	0.50	1.29
November.....	35.8	71	—19	1.54	1.50	2.86
Fall.....	49.0			6.50	3.65	7.05
Year.....	45.6	106	—30	29.55	18.06	40.23

It will be observed that the normal winter temperature is 18.9°; spring, 45.3°; summer, 68.9°; and fall, 49°. The mean annual temperature is 45.6°.

The average rainfall of 29.55 inches is well distributed throughout the year, the average for the summer months of June, July, and August being 10.69 inches.

Three of the eight climatic provinces of Wisconsin are represented in Columbia County. The western portion of the county is included in the Wisconsin River Valley; the southeastern part lies within the drainage basin of Rock River; while the northern and north central portion of the area drains into the Fox River, and thus forms a part of the Fox and Wolf River basin province. The average temperatures are hardly typical of any one of these three provinces, but rather represent an average of climatic conditions as they prevail throughout these various sections. The shortest growing season between killing frosts is in the extreme northwestern portion of the county, where the range appears to be from 130 to 140 days. In the southern and southeastern parts records indicate that the season ranges from 150 to 160 days between killing frosts. At Portage, where records have been kept by the U. S. Weather Bureau for a long period of years the average length of growing season is 150 days. The average date of the last killing frost in the spring being May 3, and that of the first killing frost in the fall being October 4. Figures No. 2 and 3 indicate the average dates of the first killing frost in the fall and the last in the spring in all parts of the State. From the date given on the two maps the average approximate length of growing season for any point may be readily determined.

In general it may be said that the conditions prevailing throughout Columbia County are representative of a considerable area in south-central Wisconsin. The climate is healthful, though subject to marked changes in temperature. The winters are long and severe, the temperature sometimes falling as low as 30° F. The snow usually remains on the ground from December to March, and this affords protection to such crops as alfalfa, clover and wheat. The summers are pleasant and all growth is rapid. The mercury sometimes reaches 100°, but extremes of both heat and cold are rare and of short duration. The hottest periods during the summer months seldom continue for more than a few days, and it is unusual for the temperature to remain below zero for more than a few days at a time during the winter. The water supply is abundant and of very good quality.

SUMMARY

Columbia County is located in south-central Wisconsin and comprises an area of approximately 799 square miles, or 511,360 acres.

The surface features vary from broad, undulating prairies to steep rolling lands, the roughest section being found in Caledonia Township and in the extreme southwestern corner of the county. There are but few places where modern farm machinery can not be readily used. The greater part of the surface is undulating to gently rolling. Low, marshy tracts are numerous throughout the county, especially in the valleys of the Wisconsin and Fox Rivers. These streams, with the headwaters of the Rock River, receive the drainage waters of the entire survey.

The county was visited by white men as early as 1673, though the first settlement was not made until 1836. It was organized in 1846, with Portage as the county seat. The county had a population of 31,129 in 1910.

Columbia County is well supplied with railroads, which provide excellent transportation facilities. It is but 93 miles from Portage to Milwaukee and 178 miles to Chicago. These cities provide excellent markets for farm produce.

Ten soil series, including 29 soil types, were recognized and mapped in the area. Of these the most important are the Miami soils represented by a silt loam, loam, fine sandy loam, and fine sand. The series includes the light-colored, timbered glacial soils carrying considerable limestone material. The silt loam and fine sandy loam members are extensively developed and are important agricultural soils.

The Carrington series is represented by three types, the silt loam, loam, and fine sandy loam. The silt loam is the most extensively developed and constitutes some of the best agricultural land in the State.

The Coloma series includes the light-colored upland timbered areas where the soils have been derived largely from glaciated sandstone material. The types mapped in this county are the Coloma fine sandy loam and fine sand.

The Plainfield series represents light-colored soils of alluvial origin, occupying level terraces or outwash plains, where the parent material is largely of sandstone origin. The types mapped are Plainfield fine sandy loam, sandy loam, sand and fine sand. These soils are all easy to work, but require careful management.

The Fox series is similar to the Plainfield but differs from it in having been derived largely from glacial material containing limestone. The types mapped are the Fox silt loam, fine sandy loam, and fine sand. All of these types are of limited extent.

The Genesee series represents light-colored soils occupying first bottom lands which are subject to overflow. The Genesee sand and fine sand were mapped. These are both of limited extent and low agricultural value.

The Knox series includes light-colored soils supposed to be largely of loessial origin. The silt loam is the only type mapped in this area and it is of very limited extent.

The Boone series includes light-colored soils derived from the weathering of sandstone. Only one type—Boone sand—was mapped. It is of very limited extent and low in value.

The Clyde series includes dark-colored poorly drained soils in old lake and pond beds and along stream channels, where there are varying amounts of lime carbonate present, especially in the subsoil. The types mapped are Clyde silt loam, loam, fine sandy loam, and fine sand. When drained these lands will make productive soils.

The Dunning series is similar to the Clyde but differs by containing little or no lime carbonate. Soil and subsoil are usually acid. In their undrained condition the soils of this series have a low value. Two types, the Dunning loam and fine sandy loam, were mapped.

Peat includes decaying vegetable matter in varying stages of decomposition, with which there is only a small amount of mineral matter present.

Muck is similar to Peat, but differs by containing a much larger percentage of mineral matter. It is usually more thoroughly decomposed than Peat. Both Peat and Muck are undrained and but little attempt has been made to utilize this kind of land.

Rough stony land is of little use, except for pasture. It includes rough rocky land which cannot be cultivated.

General farming in conjunction with dairying is the prevailing type of agriculture, although a number of special crops are grown. Wheat growing was at one time the leading industry of the county, but its production has declined and at present corn, oats, and hay are the most important crops. Of the special crops potatoes, tobacco, beans, peas, and sugar beets are the most important. The industrial development of the county has been such as to encourage the production of truck crops and fruits.

Stock feeding and the improvement of dairy and beef stock is receiving more attention throughout the county.

The adaptation of certain of the soil types to particular crops and the question of crop rotations, while quite generally recognized, should be more carefully studied. Potatoes are best adapted to the lighter soils. The sugar content in beets grown on the Miami silt loam is higher than of those grown on the Carrington or Clyde soils. The grain produced on the deep phase of the Miami silt loam is also of better quality than that grown on the black soils. Various other types are recognized as well suited to certain special and general farm crops. The farm improvements are more substantial on the heavier types than on the sandy soils. As a whole the farming communities are in a prosperous condition. The average size of farms is 141 acres, and more than 75 per cent of the farms are operated by the owners.

Agriculture in the county could be improved through the extension of the dairy industry, the growing of more alfalfa, the increase of the organic-matter content of the soil, the use of lime to correct soil acidity, more thorough cultivation, a more careful selection of seed and a better system of crop rotations.

The climate is healthful, and while there is a range of 130° in temperature throughout the year, the extremes are infrequent and of short duration. The mean annual temperature is 45.6° and the average annual rainfall 29.55 inches.

KEEP THE MAP

The Experiment Station will publish bulletins from time to time, dealing with the management of the different types mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

Wisconsin Geological and Natural History Survey

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Soil Survey in Cooperation with the College of Agriculture

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Bulletin No. L

Soil Series No. 15

RECONNOISSANCE SOIL SURVEY

OF

NORTH PART

OF

NORTH CENTRAL WISCONSIN

BY

A. R. WHITSON, W. J. GEIB, T. J. DUNNEWALD, C. B. POST, W. C. BOARDMAN,
AND A. R. ALBERT.

OF THE

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

AND

A. E. TAYLOR, L. R. SCHOENMANN AND CARL THOMPSON

OF THE

UNITED STATES DEPARTMENT OF AGRICULTURE

SURVEY CONDUCTED IN COOPERATION WITH THE UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS.

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MADISON, WISCONSIN
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MAP.

Soil Map of North Part of North Central Wisconsin.....*Attached to Back Cover*

NOTE

The soil survey of Wisconsin is being made along two lines; first a general survey of the northern and less developed portions of the State, and second a detailed survey by counties of the southern and older portions. The northern part of the State has been divided into five areas of each of which a general map of the soils is being prepared.

The first area surveyed included Portage, Wood, Clark, Taylor, Lincoln, Marathon, and portions of Price and Langlade Counties. The first survey of the soils of this area was made a number of years ago by Doctor Samuel Weidman in connection with the geological survey, and the classification followed in this work differed somewhat from that at present in use, and the maps do not show as much detail. The reports of this survey are no longer available. An entirely new survey of this area was made in 1915, and a report and map including Clark, Taylor, Marathon and Lincoln Counties will be published during the summer of 1917. Wood and Portage Counties were surveyed in detail and separate reports will be published on each of these counties.

The second area, called the South Part of North Western Wisconsin, included Polk, Barron, most of Rusk, and all of Chippewa, Dunn, St. Croix, Pierce, Pepin, and Eau Claire Counties. The edition of this report has been exhausted.

The Third area, called the North Part of North Western Wisconsin, included Burnett, Washburn, Sawyer, Douglas, and Bayfield counties, and most of Ashland County. The reports on this area are so nearly exhausted that it is only possible to loan copies for a short time.

A special report has been prepared on the northeastern portion of Bayfield County along the bay and including the islands, in which considerable development of the fruit industry is taking place. This is now available for distribution.

The fourth area called North Eastern Wisconsin includes Florence, Forest, Langlade, Oconto, Marinette, and Shawano Counties. The report on this area is now available.

This report is on the fifth area, called the North Part of North Central Wisconsin, including Iron, Vilas, Price, and Oneida Coun-

ties and the eastern portions of Ashland and Rusk Counties. A special report on the soils of Vilas County and portions of adjoining counties was prepared during the season of 1914 at the request of the Legislature when that body was considering the extent to which the development of forest reserve should be carried. Mr. T. J. Dunnewald was in charge of the field work of this survey. The map accompanying this report is included in the report on the soils of the North Part of North Central Wisconsin as well as the more important portions of the report itself, but copies of the special report and map are still available.

RECONNOISSANCE SOIL SURVEY OF NORTH PART OF NORTH CENTRAL WISCONSIN

CHAPTER I

GENERAL DESCRIPTION AND HISTORY OF THE AREA

Location and boundaries.—The area included in the Reconnoissance Soil Survey of the North Part of North Central Wisconsin



is located in the extreme north portion of Wisconsin, bordering the Upper Peninsula of Michigan. It is made up of the four counties of Vilas, Oneida, Price, and Iron, and also includes five townships

of Ashland and six townships of Rusk County. It comprises a total area of approximately 4,230 square miles or 2,707,200 acres.

Topographic Features.—The surface features are characteristic of a glacial region, and the topography varies from level to rolling and hilly, and is even quite broken in places. Part of the area consists of terminal and recessional moraines which alternate with less broken tracts of ground moraine, with basins, extensive outwash plains, and numerous swamps and lakes. In northern Iron County there are two parallel ranges which appear to have been modified but little by glacial action, as the bed rocks outcrop extensively, and where there is a covering of soil it is often thin. These are known as the Penoque Range, or the "Iron Range" because of the large deposits of iron ore, and it is the most conspicuous topographic feature in the area.

Lake Superior which borders this area on the north has an elevation above sea level of 602 feet. Lac Vieux Desert, which is the source of the Wisconsin River, has an elevation above sea level of 1630 feet. The Penoque Iron Range attains an extreme elevation of approximately 1800 feet. The drainage divide crossing the area from east to west, and sending the waters north to Lake Superior and south through the Wisconsin and Wolf Rivers, consists of a plateau from 18 to 30 miles from Lake Superior, in large part covered with swamps and lakes and so flat that in many cases the water from the same swamps may flow both north and south. South from this plateau the general slope is gradual. North it is also gradual until the Penoque Range is reached, from which there is a rapid descent to Lake Superior.

Water Power.—The streams flowing north into Lake Superior have a very rapid fall, and a large amount of power could be developed from them, but up to the present time but little development of water power in the area has been made. The Montreal River is approximately 50 miles long and from its source to Lake Superior has a fall of approximately 1000 feet. The highest gradient is concentrated within the last ten miles. The Potato River, which has its source in Iron County, but joins the Bad River in Ashland County, has a total length of 30 miles and a total fall in this distance of 900 feet. On the streams flowing south there is much less of an opportunity for water power development.

For a fuller discussion of the water power possibilities of this region see Bulletin XX of the Wisconsin Geological and Natural History Survey on "Water Powers of Wisconsin," from which the above data has been largely taken.

Settlement.—Probably the earliest permanent settlement in the region was on Spirit River in the southeastern portion of what is now Price County, where a small saw mill was established in 1860. About this mill the “Spirit River Settlement” grew up, but its growth was slow until the coming of the first railway when a small colony of Swedes located in this region. In 1880 there were two saw mills in Phillips. The first mill at Butternut was established in 1879. Other mills sprang up rapidly all along the line of the railroad.

The first railroad to reach this portion of the state was the Wisconsin Central, now owned by the Minneapolis, St. Paul and Sault Ste. Marie Railway (Soo Line). This road reached what is now Price County in 1873, and was extended on to Ashland in 1877. The City of Philips, and also Fifiield, was platted and recorded in 1876, and Butternut in 1878.

The discovery of iron and the development along this line brought many people into the northern portion of this area, and the adjoining portion of Upper Michigan. What was considered to include most of the mineral land in the Penokee Range in Iron County was entered between 1874 and '76. The first work on this range and on the Gogebic Range in Michigan was in 1878.

The early settlers of this area represent a large number of nationalities. Probably the greater proportion of the inhabitants at present are American born. As indicated elsewhere, a colony of Swedes settled in southeastern Price County, and a colony of Germans in the vicinity of Butternut in Ashland County. In the vicinity of Hurley and through the northern part of Iron County there are a large number of Polish, Finlanders, and some Italian people who first worked in the mines, woods, and mills, and later took up small tracts of land. These same classes of people are also settling in other parts of the area. Many of the settlers throughout the area came from adjoining states where land values are high, and some came from Canada.

In 1910 the population of Price County was 13,795, Oneida County 11,433, Iron County 8,306, Vilas County 6,019; and the fractions of Ashland and Rusk Counties about 2,600, making a total of approximately 32,150 for the whole area. The population is rather unevenly distributed, and there are numerous townships in which no roads or settlers are found. During the summer season thousands of people come to the lake region within the area to enjoy the fishing, boating, and delightful climate. Northern Wisconsin is coming to be recognized as the playground for the Middle West. In the fall large numbers of hunters also visit this region, for birds and deer are plentiful.

Chief Towns.—Hurley, the county seat of Iron County, has a population of about 3,000, and is one of the chief towns along the Iron Range in northern Wisconsin. Mining is the most important industry, though agriculture is gradually coming to the front in this region. Mercer, Saxon, Upson, Moore, Pence, and Iron Belt are among the smaller towns within Iron County.

The county seat of Vilas County is Eagle River, with a population of about 1200. Other smaller towns and villages in this county are Phelps, Conover, Arbor Vitae, Lac Du Flambeau, and Sayner.

The county seat of Oneida County is Rhinelander, with a population of about 6,000. This is the largest place in the area surveyed. A million dollar paper plant is located here, and this gets most of its power from the Wisconsin River. Other smaller towns within Oneida County are Pelican, Monico, Three Lakes, Woodruff, Minocqua, Hazelhurst, Harshaw, and Gagen.

Phillips, with a population of about 2000, is the county seat of Price County. There is located at this place one of the finest electrically equipped saw mills in the state. Park Falls is about the same size and also has a large saw mill. Fifield, Prentice, and Kennan are among the smaller towns within Price County.

Transportation Facilities.—Excellent transportation facilities are afforded nearly every portion of the area that is developed and lines lead into many of the undeveloped regions where lumbering is being carried on. Lines belonging to four of the largest railway companies in the State traverse the area surveyed. These are the Minneapolis, St. Paul and Sault Ste. Marie, the Chicago and Northwestern, the Chicago, Milwaukee & St. Paul, and the Duluth South Shore, and Atlantic.

Markets.—The cities, towns, lumbering camps, and mines within the area afford a market for a large amount of farm produce. Green Bay, Milwaukee, and Chicago also provide a ready market for all classes of produce. The extensive lumbering interests in this portion of Wisconsin and northern Michigan, together with the iron and copper mining districts, require large amounts of produce, and for this Chicago prices plus freight charges are usually paid when it can be secured locally. It is therefore to the advantage of the farmers within this region to attempt to supply this market.

Public Roads and Schools.—Within the area extensive settlements are limited and there are large tracts of undeveloped country where there are no public roads. The main roads between towns are usually graded and kept in good repair, while side roads are usually not given much attention. A number of roads are now being improved under the State Highway Law, through which the State cooperates

with the county and township. All such roads are constructed under the supervision of the State and are built according to the most improved scientific methods. All of the counties in the area are now making road improvements under this provision and considerable progress has been made.

Rural free delivery mail routes have been established in nearly all portions of the present survey, and by far the greater proportion of the families of this region have their mail delivered daily. The rural telephone is also in common use, and many farmhouses are supplied with this convenience.

The rural school buildings will average of better grade than those in the southern portion of the State. In a number of instances several districts have consolidated, and the children are carried to and from school in public conveyances.

ORIGIN AND GENERAL NATURE OF SOILS

The underlying rocks from which most of the soils of this region were formed are of igneous character, largely of granite, syenites, and other crystalline sorts. A small area of sandstone occurs in the northern part of Iron County. From these rocks a residual soil had been formed preceding the glacial period. During the glacial period the ice moving largely from the northeastward brought a large amount of loose surface material from the adjacent portion of northern Michigan, and at the same time removed much of the residual soil previously formed, carrying it farther to the southwest. In this way a large amount of sand was brought from the sandstone region of northern Michigan and deposited in Vilas, northern Oneida, and eastern Price County.

A small area of Superior clay soils in northern Iron County and in other parts of this region, were originally deposited by the lake water and in part have been worked over by the ice of later glacial periods.

The glacial period did not consist of a single invasion of the ice, but of several, the material of which the geologist has been, able, with more or less certainty, to distinguish. While most of the glacial action above mentioned is that of the last glaciation, the flow of which was from the northeastward, preceding ice invasions had come from the northwest and were much older. The soils of some portions of this area were almost entirely formed by this earlier ice invasion—the later ice sheet apparently having flowed over it with very little effect. For the most part the soils mapped as

Colby were formed by the earlier ice invasions, and those classed as Kennan are of the last ice age, but in the mapping of the soils their physical character and agricultural value has been given first place, and no particular effort has been made in this study to distinguish the soils deposited by the different ice sheets.

From a geological point of view, the soils, therefore, include ground moraine of different ice ages, recessional moraines of which there are a considerable number, over-wash plains, and stream terraces. As this report is intended primarily for agricultural readers, no attempt is made to discuss the geology of the region.

The Kennan series is the most extensive and consists of glacial material which has been derived largely from crystalline rocks. It is light colored and formed part of the Late Wisconsin Drift Sheet. It is always sufficiently rolling and the subsoil is sufficiently porous so that the natural drainage is always fair to good, and no mottled condition is found in the subsoil. The types mapped as belonging to this series are the silt loam, loam, and fine sandy loam.

The Colby series is very similar to the Kennan and is glacial material from crystalline rocks, but appears to have been deposited by an older ice invasion; and the material is more thoroughly weathered, the topography is more level, and there are fewer boulders upon the surface. The subsoil is always mottled and the natural drainage conditions are somewhat inferior to those of the Kennan series. The types mapped were the silt loam and fine sandy loam.

The Mellen series includes soils derived by glacial action from the Huronian iron bearing rocks, to which has been added a considerable amount of material of sandstone origin. In texture, topography, color, and structure the soils very closely resemble the Kennan. The types mapped were silt loam, loam, and fine sandy loam.

The Vilas series embraces all glacial-till soils which are derived from crystalline rocks or Keweenawan sandstone and which are lighter than a fine sandy loam in texture. It comprises the bulk of the rolling white pine lands of the area. The sandy loam portion has a fair water-holding capacity, but the lighter types are subject to drought. The types mapped as belonging to this series are the sandy loam, fine sand, sand, and stony sand.

The Superior series is made up of soils composed largely of heavy lacustrine or lake laid material having a characteristic red or pinkish red color in the subsoil. Certain areas have been more or less modified by glacial action giving rise to a rolling topography and a surface soil different from the characteristic red clay. The loam is the only type of the typical soil mapped in the area, but rolling phases of fine sandy loam, loam, and clay loam were mapped.

The Antigo series includes all alluvial soils of a heavier texture than a sandy loam and occurs as glacial outwash plains, glacial terraces, and filled in valleys. The surface is level but owing to the presence of a gravelly porous subsoil, the drainage is usually sufficient. Only two types—the silt loam and fine sandy loam were mapped.

The Plainfield series consists of light colored soils of the outwash plains, terraces, and filled in valleys. Only soils of a lighter texture than fine sandy loam are included in this series. These soils as a rule have a low water-holding capacity and a comparatively small amount of original virgin fertility. Three types—the sandy loam, sand, and fine sand were mapped in the area.

The Coloma series includes light colored glacial material occurring chiefly as ground moraine, where the material has been derived largely from the Potsdam sandstone. The topography is quite rolling and the soils are subject to drought. Only one type—the Coloma sand was mapped.

The Genesee series represents light colored first bottom soils within the glaciated region. Genesee sandy loam is the only type mapped as belonging to this series.

Peat includes decaying vegetable matter in varying stages of development, with which there has been incorporated in some cases small amounts of mineral matter.

Rough stony land includes tracts where extensive rock outcrops occur, and where the surface is so steep and rocky as to be unsuited to agricultural development.

SOIL CLASSIFICATION

Many of the most important qualities of the soil depend on the relative amounts present of soil of different sized grains. This is called the *texture* of the soil. In order to classify soils it is therefore necessary to determine the relative proportion of the soil made up of each of the different sized grains. This separation of the soil is called *mechanical analysis* and in the system most commonly used seven different sizes of grains are recognized and named as follows: fine gravel, coarse sand, medium sand, fine sand, very fine sand, silt, and clay. Practically all soils have at least a small amount of each of these different sizes. The following table gives the average texture of the most important classes of soils:

14 SOIL SURVEY OF NORTH PART OF NORTH CENTRAL WISCONSIN.

Average Texture of Important Classes of Soils.

Class of Soil	Mechanical analysis giving average percentage of soil separates in each class.						
	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Coarse sandy soil.....	5	15	25	30	10	10	5
Sandy loam soil.....	5	10	10	25	15	20	15
Fine sandy loam soil...	1	4	5	20	25	30	15
Loam soil.....	1	3	4	15	20	40	17
Silt loam soil.....	1	1	2	6	10	60	20
Clay loam soil.....	0	1	2	5	15	42	35
Clay soil.....	0	1	2	5	12	30	50

Soils, of course, vary in many other respects than texture, due to their origin. This affects the topography or lay of the land, drainage conditions, and chemical composition including the amount of organic matter. All of these factors are included in the series to which proper names have been given. The Kennan series, for instance, as mapped in this area, includes three types differing in textures, but all of which were formed by glacial action on granitic rocks and are low in organic matter and undulating to rough in topography. Each of the other series, such as the Colby, Vilas, etc., have similar characteristics which are described in the following pages.

For convenience in discussing their agricultural value and management these 28 types of soil are classified into five groups—(1) a group of heavy soils, (2) a group of medium heavy soils, (3) a group of medium sandy soils, (4) a group of sand soils, and (5) a group of poorly drained soils.

CHAPTER II

GROUP OF HEAVY SOILS

KENNAN SILT LOAM

Extent and Distribution.—The Kennan silt loam with its rolling phase, which is described later, is one of the important types in the present survey. The most extensive tract is located in the north-western portion of Price County in Towns 38, 39, and 40 North, and Range 1 and 2 West. Another important tract is found in the extreme southeastern part of the county in Town 34, Range 3 East. In the eastern part of Rusk County there are a number of small areas, and in Oneida County immediately north of Lennox there is a tract of several square miles of excellent land of this type. Other smaller patches are found in various parts of the survey.

Description.—The surface soil of this type consists of a brown or light brown friable loess-like silt loam extending to an average depth of 12 to 14 inches. The subsoil consists of a light yellow or a yellowish-brown silt loam to silty clay loam which usually becomes somewhat heavier with depth, and silty clay loam or a clay loam may be reached at 18 to 20 inches. This heavy layer usually extends to an average depth of 30 inches; the lower portion of this section frequently contains some sand. Below 30 inches the subsoil grades into a bed of unassorted glacial till consisting of fine and medium sand and gravel with only a small percentage of silt and clay. Stones and boulders are present upon the surface, though not as numerous as on some of the other soils of the area. It is seldom that large boulders are found on this type, and most of the stones range in diameter from a few inches to 12 or 14 inches.

There are some variations in this soil worthy of note. The most important is the depth of the silty layer to the underlying lighter textured material. There are a few places, especially in Rusk County, where the depth is greater than usual and where the entire section is loess-like and sometimes entirely stone free. In a few places the heavy material was known to extend to a depth of from 3 to 5 feet. On the other hand, limited tracts were found where the sandy and gravelly material came within one foot of the surface.

Topography and Drainage.—The surface of this type varies from undulating or nearly level to gently rolling. In most cases the natural drainage is good. The slope is usually sufficient to give good surface drainage and the underlying gravelly material usually provides underdrainage. Where the surface is nearly level, however, and where the silty covering is deeper than typical, the drainage is sometimes deficient and tile drains will be found desirable and possibly necessary when such tracts are improved.

Origin.—It appears that this type of soil has had its origin both from the weathering of the loess-like mantle that covers the till as well as from the weathering of the glacial till itself. With the possible exception of the silty covering, the material forming this soil consists of unassorted glacial till which was deposited by the ice sheet in the form of ground moraine, and which extends to a depth of from a few feet to over 100 feet. The material was practically all derived from the crystalline rock formation which underlies the greater part of the area. No calcareous rocks are present and both soil and subsoil are found to be in an acid condition.

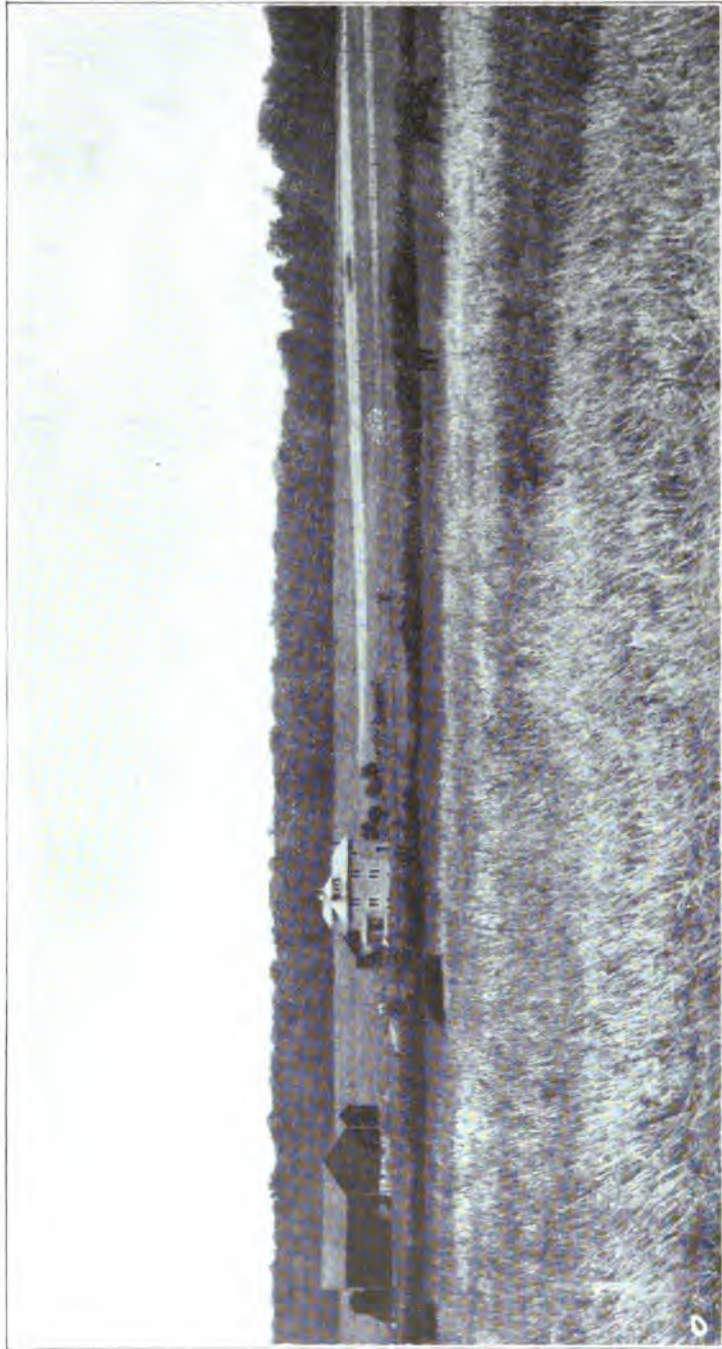
Native Vegetation.—The timber growth consists chiefly of maple, birch, and hemlock. Basswood, elm, and white pine are found in smaller numbers. Most of the pine has been cut, but the greater proportion of the hardwood is still standing. Some very fine timber was seen on this soil, especially in northwestern Price County.

Agricultural Development.—Only a small proportion of this soil is cleared and under cultivation, although it is one of the most desirable types in the area. Much of it, however, is located at a considerable distance from transportation lines, and much of it is also still in virgin forest. The largest amount of cleared land is in the southeastern part of Price County. The type of farming followed is general farming with dairying developing into the most important feature. The crops grown and the yields obtained are oats 40–60 bushels, hay from 2 to 3 tons, potatoes from 150 to 250 bushels per acre. These are the most important crops grown at present but in addition corn is raised for silage, and frequently allowed to mature when danger from frost seems slight. From 40 to 50 bushels per acre are secured. The silage yields well and is of excellent quality. A small amount of barley is also grown, but not as extensively as oats. Grasses do very well, and the cut-over lands afford excellent grazing. Clover does very well, especially on new land. Very satisfactory returns can often be secured from the clover seed. Peas and sugar beets will do well, and could be successfully raised. Wheat can also be successfully grown.



TYPICAL VIEW OF IMPROVED FARM LAND ON KENNAN SILT LOAM

This soil is confined largely to Northwestern Price, Ashland and Iron counties. It is an excellent soil and capable of being highly improved. Most of it is still timbered.



COLBY SILT LOAM.

View showing typical surface features and well improved farmstead. This soil is confined chiefly to southern Price and eastern Rusk counties. It is excellent grass land and well adapted to general farming and dairying.

KENNAN SILT LOAM—ROLLING PHASE

Extent and Distribution.—This is one of the extensive and important types in the area. There is probably somewhat more than 125 square miles of the Kennan silt loam—rolling phase—in the area. The largest tract occurs in the portion of Ashland County included in this area, and in the adjoining portions of Iron County. Between this extensive tract and Mercer there are several other smaller patches. There are also several areas in Oneida County worthy of mention. These are in Town 35, Ranges 9 and 10, in Town 36, Ranges 7 and 8, and in Town 37, Ranges 6 and 7. Other scattering areas occur in this county and also in Price County.

Description.—The rolling phase of the Kennan silt loam is quite similar to that of the typical soil in point of texture of surface soil, but the depth is somewhat less. In this phase the surface brown or grayish-brown silt loam extends to an average depth of about 10 inches. This is smooth and friable but as a whole does not contain quite as high a percentage of silt as does the typical soil. In places a small amount of sand and fine gravel may occur, and boulders are much more common and larger than found on the typical soil. While the stones and boulders are not sufficiently numerous as to discourage agricultural development, there are places where the stoniness will delay development, and sometimes cultivation will be impossible on account of the number of stones.

The subsoil consists of a yellow or yellowish-brown silt loam which usually becomes slightly heavier with depth and frequently becomes a silty clay loam at 20 inches. At a depth of from 20 to 24 inches fine gravel is often incorporated with the material and the sand and gravel increases with depth until at 24 to 30 inches the greater proportion of the mass is made up of sand and gravel. The underlying material is unsorted glacial till, chiefly sand and gravel.

Variations frequently occur in this soil and the most important one is in the depth to the underlying sand and gravel. The chief points of difference between this phase and the typical soil are that the rolling phase is rougher, has more stones upon the surface, and the covering of silt over the subsoil is not so great as in the typical soil.

Topography and Drainage.—The surface of this type ranges from gently rolling to rolling and hilly, and even broken in a few places, though the major portion may be classed as rolling. In a few places the surface occurs in the form of parallel ridges, but this condition is not as common as in the country to the east in Forest County.

The slopes are usually long, and seldom steep enough to prevent the use of modern farm machinery. In the vicinity of Butternut in Ashland County, where the largest area of this soil is found, practically all of this soil can be placed under cultivation when cleared. In the depressions between the hills throughout this type there are numerous marshes of varying extent, and these consist chiefly of Peat.

Because of the uneven character of the surface and the loose open structure of the deep subsoil, the natural drainage is excellent and the internal drainage is very good. On many of the steeper slopes erosion will be a problem which will require attention when the land is cleared. Where fields have been cleared and cultivated on the steeper slopes small ravines soon form if the surface of the ground is not covered by a growing crop most of the time. These ravines enlarge quite rapidly and in time would cut up the fields badly unless checked. As the country is still new and as little land has been cleared, means of preventing erosion should be adopted as soon as cultivation begins.

Native Vegetation.—The timber growth on this soil consisted chiefly of hardwoods and hemlock with a scattering of white and Norway pine. Practically all of the pine has been cut but there are still some extensive tracts of hardwood and hemlock. The hardwood consists of maple, birch, basswood, elm, and a little oak. On the heavier phases of the soil maple is usually the most abundant, but as the soil becomes lighter in texture the hemlock becomes more plentiful. The basswood appears to be confined most largely to the heavier soil, and on a number of ridges where the soil is heavy basswood was found to be very plentiful.

*Agricultural Development.**—Probably about 12 per cent of the rolling phase of the Kennan silt loam is under cultivation at the present time. Most of this development is in Ashland County in the immediate vicinity of Butternut. In Oneida County where more of the soil occurs in fairly good sized tracts, there is comparatively little improvement. Where under cultivation the crops grown and yields obtained are practically the same as on the typical soil. Oats, hay, corn, potatoes, some barley, are the chief crops. Peas and root crops of various kinds do well but are not grown to any marked extent. The soil is well adapted to general farming and the tendency at present is towards the development of the dairy industry. The soil is well adapted to producing hay and grasses and where rough or stony, such tracts can be used to very good advantage as grazing land along with less stony areas which will be put under cultivation.

*For chemical composition and improvement of Kennan silt loam, including the rolling phase, see page 25.

MELLEN SILT LOAM

(Including Rolling Phase)

Extent and Distribution.—The Mellen silt loam occupies a total area of approximately 50 square miles, including both the typical soil and that mapped as the rolling phase.⁴ The typical soil occupies $\frac{1}{3}$ and the rolling phase $\frac{2}{3}$ of the total area. All of this soil is found in the northern portion of Iron County and it is confined to the vicinity of the Iron Range. The largest tract is located between the lines of the Chicago and Northwestern and the Soo Railways north of the range in the north-central portion of Iron County. Most of this is rolling phase, but a considerable area of the typical soil is found along its northern border, beginning about one mile south of Saxon and extending east for 6 to 8 miles. More of the typical soil is found immediately west of Upson, and also 4 miles southeast of Iron Belt. A few other scattered tracts of both the typical soil and the rolling phase are found in the vicinity of the range.

Description.—The surface soil of the Mellen silt loam to an average depth of 10 inches consists of a brown or grayish-brown silt loam which frequently takes on an ashen appearance in cultivated fields when thoroughly dry. The upper subsoil consists of a silt loam somewhat lighter in color than the surface material and extending to 16 or 18 inches, where a reddish-brown loam occurs. Beneath this depth the subsoil continues to become lighter in texture and grades into more sandy gravelly material at from 24 to 30 inches. In the lower subsoil a heavy reddish sticky layer is often encountered. The reddish-brown color usually continues throughout the lower subsoil, and frequently a slightly pinkish tinge is noticeable. Boulders are common upon the surface, and a small amount of gravel is frequently found over the surface and mixed with the soil. The amount of stones will range about the same as on the Kennan silt loam, there being some tracts which are nearly stone free, and others, of small extent, where the surface is nearly covered with rocks. The area mapped as the typical soil south of Saxon and extending east for 6 to 8 miles is more stony than the average and the subsoil is somewhat lighter than typical. The surface, however, is only undulating and it was therefore classed with the typical soil. Variations in texture and depth of the heavy material over the coarser gravelly subsoil are common.

Topography and Drainage.—The surface of the silt loam varies from undulating to rolling and hilly. Because of the wide variation

in the surface features, a separation was made on the basis of topography, and the roughest portion of the type is referred to in the report and is indicated on the map as the rolling phase. The typical soil varies from undulating to gently rolling. Throughout the rolling portion there are small patches of more nearly level land, which, if larger, would have been separated as the typical soil, but in this general survey such detail could not be undertaken.

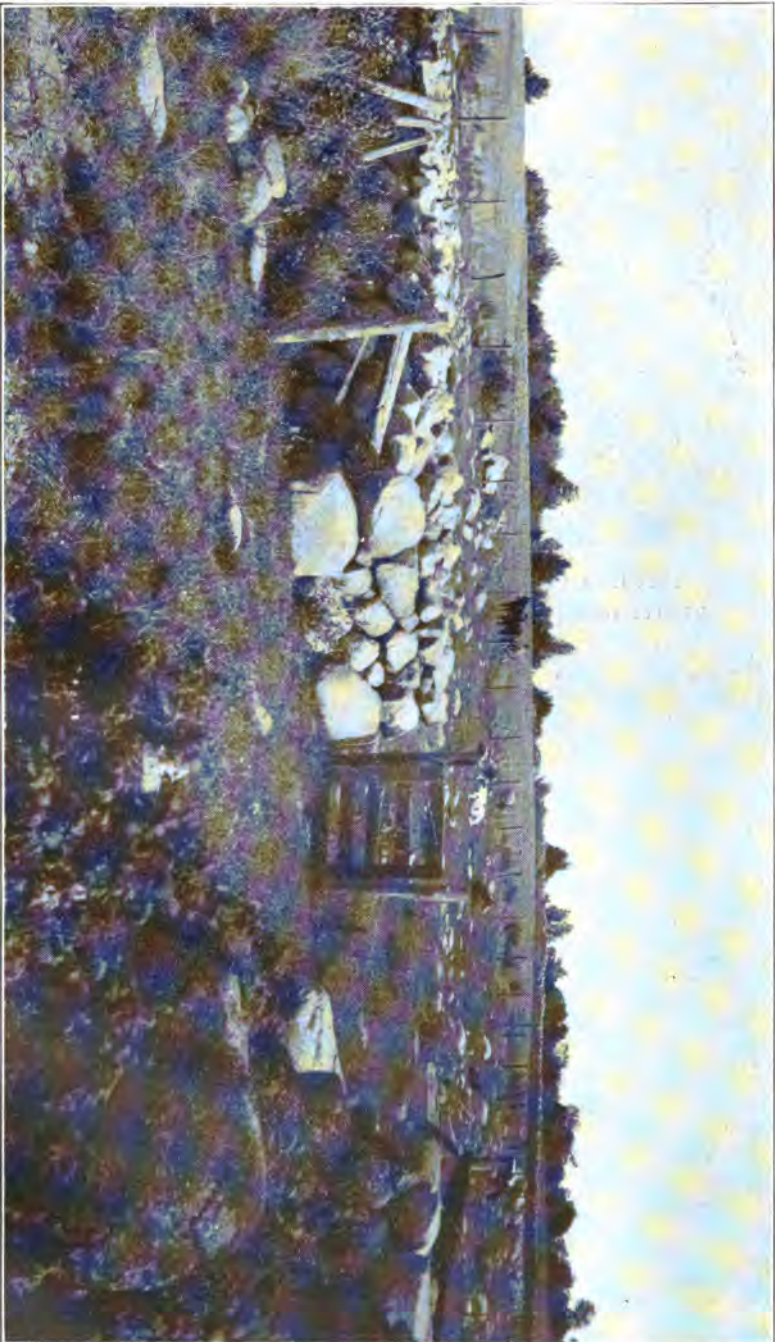
Because of the surface features and the sandy gravelly nature of the deep subsoil, the natural surface and underdrainage is good.

Origin.—The material forming the Mellen silt loam consists of glacial debris which has been ground by glacial action from the Keweenaw sandstone, Keweenaw conglomerates, and the Huronian iron bearing rocks of the iron range country. On examining the fine gravel in road cuts it is found that sandstone makes up fully 40 per cent or more of this material, while the remainder consists chiefly of gravel from dark colored rocks. The reddish color comes in part from the sandstone, which is frequently referred to as red sandstone, and in part from the iron of the iron bearing formations along the range. Refuse from the mines is often used as road building material and the wash from these red roads gives the impression that the soil as a whole has a deeper red color than is actually found on boring into the soil. No calcareous rock material entered into the formation of the soil, and both soil and subsoil are in an acid condition.

Native Vegetation.—The native timber on this soil consists of maple, birch, with some basswood, hemlock, and a few scattering white pine. Practically all of this soil is still in virgin forest.

*Agricultural Development.**—As but very little of this land has been cut over only a few farms are in operation on this soil, and data as to crop yields, etc., are therefore very limited. The agricultural value of this type is practically the same as the Kennan silt loam; and development will doubtless be along the same lines—that is, general farming with dairying as a main feature. The land is well adapted to grasses and clover. It supplies excellent grazing and small grains also do well. Potatoes and other root crops thrive, and corn can be grown as well as on other soils of the area. The stoniness will interfere somewhat with cultivation in places and steep slopes will sometimes have to be avoided, but these features will not discourage nor seriously retard agricultural development. None of the type is remote from railroads and this land will all be converted into farms as rapidly as the timber is removed.

*For chemical composition and improvement see page 25.



VIEW SHOWING THE UTILIZATION OF STONY LAND IN NORTHERN WISCONSIN.

Tracts as stony as this are sometimes found but they are of limited extent. Where the soil is a fine sandy loam or heavier such land can often be profitably cleared and utilized for cultivated crops though where very stony it is more profitable to use as pasture land.



FIG. 1. A CHEAP BUT SATISFACTORY STUMP PULLER.
The best results are obtained by supplementing its use with dynamite.



FIG. 2 THE STEAM PULLER WITH THE ATTACHMENT FOR PILING
STUMPS IN HUGE HEAPS.

This outfit does very effective and rapid work. The cost of this equipment limits its use, however, unless financed by a company which makes land clearing a business.

COLBY SILT LOAM

Extent and Distribution.—This is one of the most extensive types of soil in the area, although it is not as widely distributed as some of the other soils. It is confined to Price and the southern portion of Oneida County, and the portion of Rusk which is included in the survey. The largest and most uniform tract occurs in the extreme southwestern portion of the survey extending from Catawba to Glen Flora, and south to the southern border of the area.

Description.—The surface soil of this type to an average depth of 10 inches consists of a smooth friable silt loam which varies in color from gray or grayish-yellow to light brown. The lower portion of the soil is frequently mottled with rusty brown, yellow, and drab. The supply of organic matter present is comparatively small, and the soil is always found to be in an acid condition.

The subsoil consists of a yellowish or yellowish-brown silt loam to silty clay loam which is highly mottled with more pronounced yellow, drab, rusty brown, and gray. To the depth of 3 feet the soil is quite uniform, except that there is a somewhat higher percentage of clay in the lower portion, so that below two feet the material is often a compact silty clay loam. Small layers of sand are not uncommon, and while the section is often entirely free from coarse material, angular gravel and rock fragments may be encountered in the soil. Stones and boulders occur upon the surface, but not in as great numbers as on the Kennan silt loam, and very seldom in sufficient amounts to retard or discourage agricultural development. The compact portion of the subsoil is frequently referred to as a hardpan, and this appears to have considerable influence upon the movement of water through the soil and upon resulting drainage conditions. Below this hardpan and below the reach of the auger there is a larger amount of sand and gravel than in the surface 3 or 4 feet. The material is not sufficiently open and porous to permit the passage of water freely as in a loam soil, neither is there sufficient clay present so that when dry the soil will crack and thus form crevices through which the soil may be aerated and surface water may pass downward. This condition makes the drainage of the Colby silt loam difficult.

While the Colby silt loam as a whole is more uniform than most soil types, there are a few variations which are worthy of note. These variations may be found in many different localities, but are most common along the margins of the type and where small tracts of this soil are associated with other lighter textured soils. The variations indicated, however, were never found of sufficient extent

or importance to map separately. In a number of places the lower subsoil below two feet was found to be compact sandy clay instead of silty clay loam. Varying amounts of fine sand were also found in the subsoil at a number of places. The mottling in the subsoil is subject to quite a wide range both in the degree of mottling and also in the coloring. Very often the entire soil is strongly mottled, while in other places only the subsoil shows this condition to a marked extent, and it is not uncommon to find a reddish tinge throughout the subsoil material. The occurrence of bowlders is irregular. Numerous areas are stone free, while over a few limited tracts large bowlders are sufficiently numerous to interfere with the use of modern farm machinery.

Topography and Drainage.—The surface of this type varies from nearly level to undulating, and sometimes very gently rolling. It frequently occurs in long gentle rolls, with a considerable difference between the highest and lowest points, but never having a pronounced slope. Usually there is sufficient slope so that the surface water will drain off quite readily. On account of the heavy compact character of the subsoil and its peculiar structure, the water does not move through it readily, and the internal drainage of the entire type is deficient. The improvement of this condition presents the largest problem in the management of this type of soil.

Native Vegetation.—The tree growth on this type consists of maple, birch, hemlock, basswood, elm, a few ash, and a scattering of white pine. Practically all of the pine has been cut, and considerable tracts of the hardwood have been cut over. There are, however, extensive forests of virgin hardwood and hemlock on this soil. Where cut over, a second growth has sprung up in which poplar and birch are the most common. In a few places where the drainage is the most deficient, as on the lower slopes, where seepage from the higher land comes to the surface, spruce and cedar are found.

*Agricultural Development.**—While the standing timber has been removed from large areas, and while there are more farms being operated in Price County on the Colby silt loam than on any other type of soil, there is, however, not over 3 per cent of the Colby silt loam which is under cultivation at the present time. The leading type of agriculture followed is general farming in conjunction with dairying, to which this class of land is well suited. Grasses make a vigorous growth, and clover does well, especially on new land where drainage conditions are fair. Oats yield from 40 to 60 bushels per acre, mixed timothy and clover hay about two tons per acre, and potatoes about 125 bushels per acre. Corn is also grown, chiefly

*For chemical composition and improvement of this soil see page 25.

for the silo, and an excellent quality of silage is secured. Flint corn will usually mature, and some of the early varieties of dent corn will mature when early fall frosts do not occur; but corn cannot be counted upon to mature every season. The soil is especially well adapted to grasses, and along old logging roads throughout the region there is always a luxurious growth of grass. When the forests are removed and the underbrush is not too dense the growth of grass is soon sufficient to supply excellent grazing. As this region is comparatively new as a farming section, no well defined systems of crop rotation have been worked out as being especially adapted to this type of soil. Probably the most common practice is to follow oats with clover and timothy for two years and then plow up the land either for corn or potatoes. The soil is somewhat more difficult to cultivate than most of the other soils of the area, but if plowed when the moisture conditions are the most favorable, but little difficulty is experienced in securing a good seed bed.

ANTIGO SILT LOAM

Extent and Distribution.—The Antigo silt loam covers a total area of approximately 45 square miles, and is found in all counties within the area, except Vilas. In Oneida County it occurs directly north of Starks and several miles to the southwest from Rhinelander on what is known as "Crescent Flats." In Price County it is found 3 miles southeast of Phillips and five miles southeast of Pennington. In Iron County it is confined to the southwestern portion. Other smaller areas occur scattered throughout these counties, and also in the parts of Ashland and Rusk Counties included within this survey. The type is closely associated with the heavy soils of the Kennan and Colby series, and never occurs within the more sandy portions of the survey.

Description.—The surface soil of the Antigo silt loam where typically developed, consists of a light brown or grayish-brown friable silt loam which extends to an average depth of 12 inches. The amount of organic matter present is comparatively small and the soil as a whole is in an acid condition. The subsoil consists of a yellowish or yellowish-brown silt loam which gradually becomes heavier with depth and grades into a silty clay loam. At a depth of from 20 to 30 inches the material grades abruptly into beds of stratified sand and gravel. The depth to the sand and gravel is variable, however, and differences of from 1 to 4 feet may occur within a distance of a few rods. There is frequently a sprinkling of gravel upon the surface and a few small stones may be present, though over

areas where the silt is best developed but little gravel and very few stones are found.

Topography and Drainage.—The surface of this type varies from level to very gently undulating. In the tract north of Starks there are a number of pot holes occurring singly and in groups, and these cause a somewhat more irregular topography, but as they are of limited extent this condition was not separated. The drainage conditions vary somewhat with the depth to the underlying sand and gravel. Where the silt covering is deepest the drainage is somewhat deficient and tile drains would be beneficial. Where the sand and gravel occur within 12 to 18 inches the drainage is usually sufficient.

Origin.—The material composing the Antigo silt loam is alluvial and occurs as outwash plains and stream terraces, and was deposited by streams issuing from the ice sheet during glacial times. The underlying rock is chiefly granite and a large proportion of the material came from this source.

Native Vegetation.—The original timber growth on this soil consisted of hardwood and hemlock with a generous sprinkling of large white pine. Of the hardwoods maple predominated, with birch, basswood, elm, ash, and oak in smaller amounts. Most of the original forests have been cut, and where not improved the land supports a second growth of poplar and birch among the stumps.

Agricultural Development.—This is one of the best soils within the area for general farming. Being level and stone free makes it especially desirable. Probably a larger proportion of this soil is under cultivation than of any other within the area. The crops generally grown and the yields obtained are oats 40 to 60 bushels, barley about 35 bushels, hay 1½ to 2½ tons, and potatoes from 150 to 200 bushels per acre. If not killed by frosts, corn yields from 35 to 45 bushels of corn per acre, and sometimes considerably more. Excellent silage can always be secured, and yields of from 12 to 16 tons per acre are usually secured.

The leading type of agriculture followed consists of general farming in conjunction with dairying, with rapid development of the dairy industry to which this soil is well adapted. The soil is very well adapted to grasses, and alfalfa can be grown successfully if lime is used. The most common rotation followed consists of corn one year followed by one or two years of small grain, which is seeded to clover or clover and timothy and cut for hay for one or two years. Clover seed is sometimes grown. Potatoes may be grown in place of corn, or they may come in as another step in the rotation.

CHEMICAL COMPOSITION AND FERTILITY OF MELLEN, COLBY, ANTIGO,
AND KENNAN SILT LOAMS

The soils of the Mellen, Colby, Antigo, and Kennan series have a good supply of the mineral elements phosphorous and potassium.

Phosphorus.—The total amount of phosphorous in an acre to a depth of 8 inches varies from 1100 to 1400 pounds. This would be sufficient for 100 to 150 crops if all were available, but it is never practicable to secure good growth from such soils after the total phosphorus has been reduced to six or eight hundred pounds and better results are always secured when the total phosphorous content of this layer of soil is retained at from 1500 to 2000 pounds per acre 8 inches. A farmer on this land, therefore, should adopt plans which will maintain the present supply of this element rather than attempt to draw on it even for a short number of years. The availability of this element requires a good supply of organic matter.

Potassium.—The element potassium exists in very much larger amounts in these soils than does the element phosphorous—in fact they contain on the average approximately 30,000 pounds of this element per acre to a depth of 8 inches. This is a sufficient supply to meet the demands of heavy crops for several hundred years. The entire problem with reference to potassium, therefore, is connected with its availability. When a good supply of active organic matter is present it can be assumed that there is sufficient potassium made available for practically all crops grown on this land. In the case of a few special crops requiring unusually large amounts of this element, such as cabbage and tobacco, the use of potash fertilizers may in some cases be profitable. The system of farming followed will also influence the potassium supply. A large part of this element goes to the stalks and straw of the plant so that if the hay and rough forage is fed the greater portion of this element is returned to the land in the manure—differing radically from phosphorus which goes to the grain and is, therefore, more likely to be sold.

Organic Matter and Nitrogen.—Compared with prairie soils which have shown a lasting fertility, these soils are distinctively low in organic matter and nitrogen. In fact, most upland soils of wooded regions are low in organic matter. However, the vegetable matter which they do contain when first cleared and broken is of an active character, but provision should be made for maintaining and increasing this material. When stock raising is practiced manure is available and is of course good as far as it goes, but on comparatively few farms is there sufficient manure produced to maintain the organic matter in soils of this character and other means should be used to

supplement the barnyard manure. Green manuring crops should be used as far as possible, turning under the second crop of clover whenever this can be done rather than using it for pasture. Seeding clover in corn at the last cultivation will secure good growth when the season is favorable. Cultivated ground when used for pasture should not be grazed closely.

Nitrogen is perhaps the most essential element of plant food and large amounts are used by all crops. It exists only in organic or vegetable matter of the soil, there being none whatever in the earthy material derived from the rocks. Soils which are low in organic matter are, therefore, also low in nitrogen. By all means the cheapest source of this element is through the growth of legumes such as clover, alfalfa, soybeans, etc., which collect it from the atmosphere. When these crops are turned under they contain an abundance of this element. When fed to stock a portion only is returned to the land. But when land of the character of that under discussion is used for mixed farming so that at least one-fourth produces a good crop of clover or alfalfa each year the supply of nitrogen can be maintained on a dairy or stock farm, but where any considerable portion of the land is in crops which are sold entirely one-third or more would have to be in some legume crop to maintain the nitrogen supply.

Acidity and Liming.—Since all of these soils were formed from rocks not containing lime carbonate they are essentially all acid. The degree of acidity varies from one which would require 1000 to that which would require 5000 pounds or more lime to correct. This acidity is not in itself a direct detriment to the growth of most farm crops, but does interfere with the growth of the best legumes. Clover will do well while this soil is new even though acid, but after this land has been cropped a number of years the acidity should be corrected to secure the best results with medium red or mammoth clover. Alfalfa is very sensitive to acidity and lime in some form must be used to secure good results with this crop even on new land.

Crops.—The Mellen, Antigo, and Kennan soils are adapted to a wide range of crops including corn, potatoes, and root crops as well as grasses and small grains. The Colby soils are not particularly well adapted to root crops on account of their rather inadequate subsoil drainage and their stickiness. They are, however, exceptionally well adapted to grains and grasses. Fields on the Colby soils having good slope and surface drainage can be made to produce good crops of corn by careful management. The soils of these types are well adapted to the development of dairy farming on account of their unusual fitness for the growing of hay and pasture.

SUPERIOR CLAY LOAM—ROLLING PHASE

Extent and Distribution.—The Superior clay loam—rolling phase is of very limited extent and does not extend over a total area of more than 4 square miles. One small tract occurs 4 miles east and $\frac{1}{2}$ mile north of Ogema in Price County, and the remainder is all confined to the extreme northern part of Iron County within a few miles of the shore of Lake Superior. The largest tract is found about 2 miles northwest from Saxon.

Description.—The surface soil of the Superior clay loam to an average depth of 8 inches consists of reddish-brown clay loam, over the surface of which there is frequently an inch or two of lighter colored silty material. The subsoil consists of a heavy compact red clay which extends to a depth of more than 3 feet. A few pebbles may be mixed with the soil and subsoil, but the surface is practically stone free.

Topography and Drainage.—The surface of this type varies from gently rolling to rolling. It is not cut up by ravines to as great an extent as is some of the Superior loam and practically all of the soil can be cultivated and farmed with modern machinery. Because of the surface features the natural drainage is good, but the heavy subsoil makes the movement of water through the soil rather slow, and where low places occur between areas of higher land a line of tile drain may be found profitable.

Origin.—The material forming this soil has been derived from the weathering of lacustrine deposits, which since their first deposition have been modified by glacial action. The mass of the material is quite calcareous, but the surface has been leached to such an extent that a slightly acid condition now exists in places.

Native Vegetation.—The original timber growth consisted chiefly of maple, birch, pine, and some hemlock. All of the merchantable timber has been removed, and most of the land is in the “cut-over” stage of development.

*Agricultural Development.**—Probably about 15 per cent of this type is under cultivation at present, and practically all farms being operated are the homes of new settlers. This is a very good general farming soil and is developing along the line of general farming and dairying. Oats, hay, and potatoes are the chief crops. It is very well adapted to clover and grasses, and the land not being cultivated provides excellent grazing as soon as the brush is removed. This type is more difficult to cultivate than the lighter textured soils, but if plowed when the moisture conditions are the most

*For chemical composition and improvement of this soil see page 30.

favorable but little difficulty is experienced in securing a good seed bed.

It is thought that the fruit industry, especially the growing of apples, could be profitably developed on this type of soil.

SUPERIOR LOAM

Extent and Distribution.—The Superior loam is all confined to the northern portion of Iron County and the major portion of it occurs in one solid body, beginning about one mile north of Saxon and extending to the northeast to the Montreal River, which stream it borders for a distance of over 5 miles. It occupies a total area of about 10 square miles.

Description.—The surface soil of this type to an average depth of 10 inches consists of a brown to a grayish-brown loam. This is underlain by a somewhat lighter colored loam which at a depth of from 16 to 24 inches grades into heavy red clay. This heavy compact red clay extends to a depth of over three feet. In a few places lenses of fine sand were encountered in the subsoil, but such variations were of limited extent. The type as a whole is very uniform.

Topography and Drainage.—The surface of the Superior loam is level to very gently undulating, and on account of this and the heavy nature of the soil and subsoil the natural drainage is deficient, and tile drains are needed.

Origin.—The material forming this type has been derived from the weathering of lacustrine material, which may or may not have been modified to a limited extent by glacial action. The lacustrine material is calcareous, but the soil has been leached so that the amount of lime carbonate in the subsoil is much greater than is now found in the surface. In fact, an acid condition may be found in places in the surface few inches.

Native Vegetation.—The timber growth on this soil consists of maple, birch, hemlock, with scattering white pine. Most of the timber has been removed and poplar forms the second growth in many places. Over the eastern portion of the type along the Montreal River there is some standing timber and logging operations were being carried on while the survey was in progress.

*Agricultural Development.**—Only a very small proportion of this type is in farms and under cultivation at the present time, and most of the people on the farms now in operation are new settlers; so that the amount of crop data available for this particular soil is limited. It may be said, however, that this is a very good general farming

*For chemical composition and improvement see page 30.

soil, and well adapted to grasses, clover, small grains, and root crops. Potatoes give good yields, but the soil is not so well adapted to this crop as are some of the lighter textured soils. General farming and dairying are the lines along which development is now taking place. While corn cannot be expected to mature every year, it frequently ripens, and can always be counted on to supply excellent silage.

SUPERIOR LOAM—ROLLING PHASE

Extent and Distribution.—This type occupies a total area of approximately 8 square miles. The greater proportion is found in one body in the vicinity of Saxon and extending along the D. S. S. A. Railway for a distance of about 6 miles. Another smaller tract occurs to the northeast of Saxon bordering the Montreal River.

Description.—The surface of the Superior loam—rolling phase—to an average depth of 10 inches consists of a heavy loam which takes on a reddish-brown color and becomes heavier with depth. The subsoil consists of a heavy compact red clay which extends to a depth of over 3 feet. Frequently a small amount of fine sand may be incorporated with the subsoil, and small pebbles sometimes occur both in the soil and subsoil. The type is quite free from stones and boulders, and there are no rock outcrops to be seen.

Topography and Drainage.—The surface varies from undulating to rolling. Over the portions of the type which are in general the most nearly level, there are frequently small ravines from 10 to 12 feet deep which cut up the surface and interfere somewhat with cultural operations. This condition prevails most extensively in the type as found bordering the Montreal River, while over the tract about Saxon the surface is rolling, but not cut up by ravines. On account of the surface features the natural drainage is good. The subsoil, however, is very heavy, and on long gentle slopes tile drains could be installed with profit even though the surface water may escape readily.

Origin.—The material forming this type is largely of lacustrine origin, but since its first deposition it has been influenced to a greater or less extent by glacial action and there has been incorporated with it small pebbles and varying amounts of sand, which are usually not found in the purely lacustrine beds. The mass of this material is calcareous but the surface soil has been leached to such an extent that a slightly acid condition is frequently found.

Native Vegetation.—The original timber growth consisted chiefly of maple, birch, and hemlock, with a second growth largely of poplar.

Practically all of the merchantable timber has been removed from this type.

Agricultural Development.—While this soil is limited in extent there is probably a greater proportion of the type under cultivation than is the case with other soil in the present survey. Fully 40 per cent of the Superior loam is being cultivated and more is being included in farms each year. It is a good general farming soil and because of its freedom from stones it is often selected in preference to other types. The chief crops grown are oats, hay, and potatoes, and all of these give good yields. Clover and grasses do especially well, and while corn is not grown to such extent it provides excellent silage and frequently matures when early varieties are grown. Dairying is the leading branch of farming and the land is well suited to this type of agriculture.

The fruit industry, especially the growing of apples could doubtless be profitably developed on this soil.

CHEMICAL COMPOSITION AND FERTILITY OF SUPERIOR LOAM AND CLAY LOAM

The chemical analysis of the Superior loam and clay loam soils shows that their phosphorus content is somewhat lower than the average of other silt loam and clay loam soils in the state, while the potassium content is considerably larger. Their content of organic matter is somewhat below the average of soils of this texture. In regard to lime they vary within very wide limits, in some sections being acid, while in other they contain as high as 25 or 30 per cent of lime carbonate.

Phosphorus.—The comparatively small total amount of phosphorus contained in these soils together with the relatively large amount of iron oxide renders this element somewhat unavailable to growing crops and makes it important that farmers operating on this type of soil see to it that the available supplies of this element are maintained or increased either through the use of feeding stuffs high in this element or the purchase of sufficient phosphate fertilizers. Experiments on this soil at Ashland showed a large increase through the use of phosphate fertilizers in addition to manure. The following table gives the results of some of these experiments.

Crop	10 tons manure only	10 tons manure and 1000 lbs. rock phosphate	Per cent of increase
Potatoes.....	87 bu. per A	128 bu. per A	47
Rutabagas.....	108 bu. per A	137 bu. per A	27
Corn.....	30.4 bu. per A	36.8 bu. per A	21
Clover Hay.....	2223 pounds	3177 pounds	43
Clover Seed.....	217 pounds	336 pounds	47

The importance of having sufficient supplies of this element is made still greater by the relatively poor drainage which the Superior clay loam has and its consequent tendency to be cold so that crops are slow in maturing. The element phosphorus is particularly helpful in hastening the maturity of crops and the formation of seed.

Potassium.—These soils average over 50,000 pounds of this element per acre to a depth of 8 inches. This potassium, however, in the form in which it exists in the soil is not available to crops and becomes so only as a result of chemical changes which are chiefly brought about through the action of organic matter. When a good supply of active organic matter is maintained the quantity of potassium is sufficient to supply growing crops almost indefinitely and it is only in the case of fields low in organic matter or where crops using unusually large amounts of available potassium are grown that fertilizers containing this element need be used.

CHAPTER III

GROUP OF MEDIUM HEAVY SOILS

KENNAN LOAM

(Including Rolling Phase)

Extent and Distribution.—The Kennan loam occupies a total area of at least 100 square miles. It is confined to Price, Ashland, and Iron Counties, with by far the most extensive tracts in Iron County. The greater proportion of this type is found in a belt extending in a northeasterly and southwesterly direction through Iron and the southeastern portion of Ashland County, and lying between Turtle River and the Mellen soils which occur in the vicinity of the Iron Range. Areas of this soil range in size from a square mile or less to 10 or 15 square miles. In Price County the type is limited to a few small scattered patches, none of which are over 3 square miles in extent. Most of these occur in the east-central and the southeastern portions of the county.

Description.—The surface soil of this type to an average depth of 12 inches consists of a light brown or grayish-brown loam containing a high percentage of silt and fine sand. The subsoil is a yellowish-brown loam, which grades into a yellow silty fine sandy loam or a sandy clay loam. The subsoil sometimes grades into material which is quite gravelly below three feet. Some gravel may be found upon the surface and scattered through the soil section, and bowlders are plentiful upon the surface. The stoniness is about equal to that of the Kennan silt loam, and as on that soil there are numerous areas which are stone free. The stony condition is not such as to retard or discourage agricultural development.

Where the soil occurs in small tracts as in Price County it is frequently quite variable, and ranges from a fine sandy loam to a silt loam, depending upon the character of the soils with which it may be associated.

Topography and Drainage.—The surface of this type ranges from undulating to rolling, with the greater proportion having a topography which is gently rolling. The amount of territory which is

undulating is rather small. On the soil map the rolling portion of the type is indicated by crosslining. On account of the topography the natural drainage is good.

Native Vegetation.—The predominant growth on this soil is maple and birch, with a small amount of hemlock and basswood, and a scattering of white pine. The greater proportion of the soil of this type in Iron County is still in virgin forest.

*Agricultural Development.**—Only a very small proportion of this type is under cultivation at the present time. The cultivated tracts occur chiefly in southeastern Ashland County in T 42 and 43 N-R 1 N where a few farms are being operated. This is a very good general farming soil—in fact, it may be considered as among the best in the survey. The type of farming which is being developed, the crops grown, and the yields obtained are practically the same as on the Kennan silt loam. The chief crops are oats, hay, potatoes, corn, and some barley. Root crops are also grown on a small scale by some of the farmers. Clover and grasses do very well, excellent corn silage can be produced and the region is well adapted to the development of dairying along with general farming.

KENNAN FINE SANDY LOAM

Extent and Distribution.—The Kennan fine sandy loam is one of the most extensive types of soil in this area, and it is well distributed throughout the region covered, being found in every county except Rusk. Probably the most extensive tract occurs in the northeastern portion of Price County, beginning some distance south and west from Phillips and extending to the north and the northeast into Ashland County. In the vicinity of Park Falls and for about nine miles east this is the predominating type. In Vilas County important tracts occur in the vicinity of Phelps and about Winchester, while in Oneida County it occurs about Sugar Camp and Thunder Lakes, about Oneida and Hancock Lakes, in the vicinity of Goodnow, and to the southwest from Rhinelander. There are numerous areas south of the Iron Range in Iron County and in the southeastern part of Ashland County. Smaller irregular patches are also found through various portions of the survey.

Description.—The surface soil of the Kennan fine sandy loam to an average depth of 12 inches consists of a brown, or slightly reddish-brown, or grayish-brown fine sandy loam. The lower portion of the soil section frequently becomes somewhat coarser in texture and approaches a sandy loam. The subsoil consists of a light brown or

*For chemical composition and improvement see page 45.

yellowish-brown fine or medium sandy loam with which there may be varying amounts of fine gravel incorporated. More sand and gravel are encountered with depth, and the deep subsoil is usually a gravelly sandy loam grading into unassorted glacial till consisting of coarse sand, gravel, stones, and only a very small proportion of silt and clay. Some stones and boulders are found upon the surface.

Variations in the surface soil are frequent, but none of them were found to be of sufficient extent or importance to warrant separating the type into phases on the basis of texture. In Town 41, Range 10 the heaviest soil, which ranges from fine sandy loam to a loam, is found upon the wooded ridge tops, while the lower slopes and valleys often have a lighter soil. In places south of Tenderfoot Lake and east of Phelps the soil also becomes a heavy fine sandy loam. This same condition was found in a number of other sections of limited area. On the other hand, small patches frequently occur where the surface approaches a fine sand. In the vicinity of Winchester a red clay layer was found in local areas. This layer varies from a few inches to six feet in thickness and lay at or near the surface, and sometimes at a depth of five feet. This layer may be seen in railroad cuts and it indicates its presence by an undrained and springy condition. In all cases the clay was found to be underlain by a sandy gravelly loam subsoil.

Topography and Drainage.—The surface of the Kennan fine sandy loam varies from undulating to gently rolling. The most rolling portion is usually found along stream courses or bordering lakes or swamps. Where the surface became extremely broken or morainic over large areas, such tracts were separated and indicated as the rough phase, but where variations of this kind were of only limited extent, no separation was made. The surface of practically all of the typical soil is such that improved farm machinery can be used upon it when the land is cleared and placed under cultivation. Some kettle basins and other small depressions are sometimes found, and marshes are very often found associated with this type, as with many other types within the survey. On account of the sandy gravelly nature of the subsoil and the character of the surface, the natural drainage is good.

Origin.—The material from which the Kennan fine sandy loam has been derived consists of unassorted glacial till which occurs chiefly in the form of ground moraine. There are a few places of limited extent where eskers and kames occur, and in which the material is stratified, and road cuts sometimes show stratification in the ground moraine. The parent rock from which most of the material came is chiefly granite, as this formation is found underly-



VIEW OF FARM ON KENNAN FINE SANDY LOAM, SOUTHEAST OF MERCER.

Shows very gently rolling topography and characteristic crops, with hardwood timber in the background.
This is a good general farming soil.



VIEW OF KENNAN FINE SANDY LOAM, ROUGH PHASE.

This view is characteristic of this type of soil as found in northwestern Vilas county. The soil itself is of good quality but the rough, broken surface renders it undesirable for growing cultivated crops.

ing practically all of this part of the state. A small amount of sandstone material may also be incorporated with this type, especially in the soil nearest the Iron Range country. This was carried by ice action from the shore of Lake Superior where sandstone forms the surface rock. No calcareous material has entered into the formation of the soil and both soil and subsoil are found to be in an acid condition.

Native Vegetation.—The Kennan fine sandy loam is almost exclusively a hardwood and hemlock type of soil. In the larger areas where most typically developed the timber consists of maple, basswood, birch, and hemlock, with a few scattering white pine. On the more sandy portions the hemlock usually predominates with birch usually second in point of numbers. In a few more sandy tracts the soil supported for the most part large white pine which has been cut, and only scattering oaks, hemlocks, maple, and birch remain among the heavy second growth which consists chiefly of poplar and birch. The virgin hardwood remains in places, but large amounts of it have been cut and the land is now in “slashings.”

*Agricultural Development.**—The Kennan fine sandy loam promises to be the most valuable soil of the area. Numerous small tracts have been cleared and placed under cultivation so that a good idea can be obtained as to the results which may be expected from this class of land, though probably not over two per cent of the entire type is under the plow at present. Some farming is carried on in the vicinity of Phillips, Park Falls, southwest from Rhinelander, south and west of Sugar Camp Lake, east and south of Conover, and south and east of Phelps. General farming, dairying, and the raising of small grain are the chief lines followed. The crops grown and yields obtained are oats from 35 to 60 bushels, barley from 25 to 35 bushels, corn often matures and yields from 35 to 50 bushels, hay from 1½ to 2 tons, and potatoes from 150 to 250 bushels per acre. The most common rotation consists of small grain seeded to clover or clover and timothy mixed, and this cut for hay one or two years before being plowed again for corn or potatoes. Commercial fertilizers have not been used to any extent, but a few people are now experimenting along this line. In Price County the application of 400 pounds of acid phosphate and 300 pounds of potassium sulfate resulted in a yield of 396 bushels of potatoes per acre, as compared with a yield of 258 bushels on the unfertilized plot.

*For chemical composition and improvement of this soil see page 45.

KENNAN FINE SANDY LOAM—ROUGH PHASE

Extent and Distribution.—The rough phase of the Kennan fine sandy loam covers about 60 square miles of territory, largely in the vicinity of Winchester and Winegar in northern and northwestern Vilas County. In Price County small patches of this phase were also found, but because of their small extent and irregular outline they were not separated from the typical soil.

Description.—The surface soil to a depth of 8 to 10 inches consists of a dark brown fine sandy loam. The surface 2-inches is usually grayish-brown or sometimes darker, overlying a rather heavy brown fine sandy loam, which grades into a brown loamy sand at 20 to 24 inches. The amount of coarse sand and fine gravel increases with depth. In places the deep subsoil is made up largely of reddish sandy clay loam, or a layer of red clay 2 to 4 inches thick may be found. Deeper layers of red clay are also found in the vicinity, but only occasionally in this phase of the soil. This material is the same as forms the Superior soils, but because of its limited extent and irregular occurrence no attempt was made to map this variation separately. Some stones and boulders appear upon the surface and mixed with the soil, but these are no more numerous than on the typical soil, and not as plentiful as on the Kennan silt loam. The stoniness in itself would not retard agricultural development.

Topography and Drainage.—The surface of this phase is extremely rough, broken, and irregular. It frequently consists of a series of sharp ridges between which narrow strips of marsh occur. Pits and potholes are numerous. Over the greater portion of this phase the natural drainage is excellent, but a considerable amount of wet land consisting of small gully or pothole marshes in the depressions is included. Springy slopes and pockets are also common in places. The lack of drainage in many places about Winchester is in part due to the thin layer of red clay or compact reddish sandy clay loam in the subsoil.

While small pieces of from 1 to 10 acres in extent may be found which are neither exceedingly rough nor wet, the majority of the phase is too rough and uneven to permit the use of farm machinery, and it was chiefly because of this condition that such lands were separated and indicated as a phase on the soil map.

Origin.—The material forming this phase of the Kennan fine sandy loam is of glacial origin and occurs chiefly as recessional moraines. The parent material was largely from granitic rocks which form the bed rock throughout this region. A small amount of material of sandstone origin may also be incorporated, this having been carried

by glacial action from the sandstone formations along the south shore of Lake Superior. No calcareous material is found, and both soil and subsoil are in an acid condition.

Native Vegetation.—The native timber growth consisted chiefly of hardwoods, maple, basswood, and birch, with a few scattering balsam, hemlock, and white pine. In a few places where the soil is more sandy than usual, hemlock and birch predominate, but in most cases the maple and basswood are the most plentiful. Much of the timber near Winchester and Winegar has been removed, leaving the land covered only with brush and young growth familiarly known as "cut-over" land.

*Agricultural Development.**—Little or no farming has been done on this soil. While the texture of the soil and its timber growth invite settlement, the roughness of its topography discourages any attempt at farming. The soil will produce good pasture, and portions of it could be used for stock raising where it occurs in connection with land of better topography and for that reason could be classed as soil of fair agricultural value. But where such topography occurs in extensive areas much of this soil has been classed with the soils of low agricultural value.

MELLEN FINE SANDY LOAM

(Including Rolling Phase)

Extent and Distribution.—The Mellen fine sandy loam is all confined to the northern portion of Iron County, but throughout this section of country it is well distributed. It is closely associated with the Mellen loam and Mellen silt loam. On the accompanying soil map this soil is shown by means of two colors, one representing that portion which is rolling and hilly and the other that which varies from undulating to gently rolling. The rolling phase is by far the more extensive. Probably the most extensive tract of this soil is found lying to the north and to the south of Hurley, along the Montreal River which separates Wisconsin from Michigan. To the northwest of Upsan along the Potato River there is also an extensive tract of this soil, most of which is rolling phase. The largest tract of undulating to gently rolling portion of the type occurs at Hurley, and extends west for about 4 miles. Other smaller tracts of this soil are scattered throughout northern Iron County.

Description.—The surface of the Mellen fine sandy loam to an average depth of 10 inches consists of a brown or slightly reddish brown, fine sandy loam containing only a moderate amount of or-

*For chemical composition and improvement see page 45.

ganic matter. The subsoil is also a fine sandy loam somewhat lighter in color than the surface, and also somewhat coarser. Some gravel appears upon the surface and mixed with the soil, and the amount gradually increases with depth so that on account of the gravel and stones in the subsoil it is often impossible to bore more than 20 to 24 inches with the soil auger. The deeper subsoil to 3 feet or more has a reddish or reddish-brown color and there is usually sufficient clay present to make the material compact and quite sticky when wet. The type is subject to some variation and frequently approaches a loam in the texture of the surface soil. The surface is usually quite stony, and in this respect resembles the loam and silt loam types. Rock outcrops occur frequently, and over small tracts the bed rock may be close to the surface. Usually, however, the depth to rock is from 10 to 50 feet or more.

Topography and Drainage.—As indicated above, two classes of topography were recognized on this type and a separation was made on this basis. By far the greater proportion of the Mellen fine sandy loam is rolling to hilly, with numerous small pot holes, swales, and small marshes scattered through it. The surface is more irregular and choppy than either the loam or silt loam, but there are only a few slopes which are sufficiently steep to prevent the use of modern farm machinery. The remainder of the type is undulating to gently rolling and is all very good agricultural land. Because of the surface features and the gravelly nature of the subsoil, the natural surface and under drainage is excellent, but seldom excessive.

Origin.—The material forming this soil has been derived from the weathering of glacial debris, which has been ground by ice action from the Keweenawan sandstone and the dark colored rocks of the Huronian iron-bearing formation. Of the fine gravel over 40 per cent is estimated to be sandstone, while the remainder is chiefly the dark colored rocks. Fragments of these formations make up the stones and boulders which appear upon the surface. Many of these have been somewhat rounded by glacial action, though few of the boulders have been carried more than a short distance by the ice. No calcareous material is incorporated with the glacial debris, and both soil and subsoil are in an acid condition.

Native Vegetation.—The native timber growth on this type consists of hemlock, maple, and birch, with a few scattering white pine. Where the texture approaches a loam the proportion of maple and birch becomes somewhat larger. By far the greater proportion of this soil is still in virgin forest.

*Agricultural Development.**—The only development which has taken place on this soil is in the vicinity of Hurley, where a number of

*For chemical composition and improvement see page 45.

small farms have been started, chiefly by people who previously worked in the iron mines. The chief crops grown are potatoes, hay, oats, and root crops. Clover and grasses do very well, and all portions of the type from which the timber has been removed supply excellent grazing. The type is well adapted to general farming and dairying, and this is the line along which greatest development will doubtless take place as the timber is removed. Because of the small amount under cultivation, the crop data available from this type is limited. The yields obtained, however, compare very favorably with those secured on the loam and silt loam soils. For potatoes it is probably somewhat better than the heavier types. Strawberries, bush berries, and truck crops also do well on this type, and it would seem that this industry could well be extended, since the mining country affords good markets for all farm and garden produce.

MELLEN LOAM

(Including the Rolling Phase)

Extent and Distribution.—This type has a total area of approximately 105 square miles and it occurs chiefly in one large body. The Soo Line Railway runs along the northern margin, and the towns of Montreal, Pence, Iron Belt, and Moore are located upon it. The type extends south of the Soo tracks for a distance of from 4 to 8 or more miles, being widest along the west county line and narrowest near Montreal. It covers much of the region taken up by the Iron Range, but extends south from 3 to 10 miles from the range.

Description.—The surface soil of the Mellen loam to an average depth of 12 inches consists of a brown loam which often contains a few small pebbles. The subsoil consists of a lighter brown loam or fine sandy loam, and the texture usually becomes lighter with increased depth. The amount of gravel and coarse material also usually increases with depth, but the deep subsoil often has sufficient clay incorporated with it to make it quite sticky. This material has a marked reddish-brown color. Stones and boulders are common upon the surface, but they are seldom present in sufficient numbers to discourage or retard agricultural development. In places small areas of fine sandy loam were included with this type, but as a whole it approaches a silt loam more nearly than a fine sandy loam.

Topography and Drainage.—Very nearly all of it varies from rolling to hilly, but about 5 square miles is undulating or gently rolling. The soil map indicates these conditions by means of cross lining on the color used for the Mellen loam. Where the surface is the roughest the soil is not quite as deep as where the topography is only

gently rolling or undulating. Because of the surface features and the coarse material in the subsoil, both the natural surface and under drainage are good.

Origin.—In origin this type is practically the same as the Mellen silt loam, it being composed of glacial debris ground from the Keweenawan sandstone and Keweenawan conglomerates, and from the dark colored rocks of the Huronian iron-bearing formations. Road cuts show that the fine gravel is made up of over 40 per cent of sandstone, while most of the material is of the dark colored rocks. As the type approaches the Kennan soils which it borders on the south, there is some granitic rock material mixed with the soil. This gradually increases as the distance from the range increases until there is a sufficient amount present to classify the soil as Kennan rather than as Mellen. There is no calcareous material with this type and both soil and subsoil are in an acid condition.

Native Vegetation.—The native timber on this soil consists of maple, birch, with a small amount of basswood and hemlock. There is more hemlock than is found on the silt loam type, but not as much as on the fine sandy loam soil. A few scattering white pine are also found. The greater portion of the soil is still in virgin forest.

*Agricultural Development.**—Probably not over 2 per cent of this type is cleared and under cultivation at the present time and therefore the crop data available is very limited. All of the improvement on this type has taken place along the Soo Railway, and the largest amount of cleared land is in the immediate vicinity of Iron Belt. The crops grown are oats, hay, potatoes, and other root crops, and a small amount of corn. The soil may be considered as well adapted to general farming and dairying, and the development which is now taking place is along these lines. The soil is especially well adapted to grasses and clover, and even where the most stony it is all well suited to heavy grazing. Many tracts are nearly stone free, and when such places are selected for the point at which to begin farming operations, no difficulty is experienced in dealing with the stones. The yields obtained are practically the same as on the Kennan loam and silt loam, and the type has practically the same value.

ANTIGO FINE SANDY LOAM

Extent and Distribution.—The Antigo fine sandy loam occupies a total area of about 45 square miles and is found most extensively in Price, Oneida, and Vilas Counties. The largest area occurs in central Price County extending about 7 miles to the northwest from

*For chemical composition and improvement of this soil see page 45.



VIEW OF VILAS SANDY LOAM.

Note the undulating to gently rolling surface and character of present growth. Pine stumps in the foreground and poplar, birch and second growth pine in the background.

Phillips. Another tract lies to the southeast from Phillips. An area of about 2 square miles occurs about the town of Three Lakes in Vilas County. Another tract of similar size occurs in parts of Sections 7, 17, and 18 in Town 40, Range 10, northeast of Eagle River. Two areas of about one square mile each are found south of Phelps in Town 41, Range 11 and Town 41, Range 12. An area of about 5 square miles occurs north of Arbor Vitae, while smaller tracts are scattered over Vilas, Oneida, the southern part of Iron, and a little is also found in Ashland County.

Description.—The surface soil of the Antigo fine sandy loam consists of about 2 inches of a grayish fine sandy loam, which is underlain to a depth of 8 to 10 inches by a grayish-brown or dark brown fine sandy loam. Below this the soil merges into a grayish-brown fine or medium sandy loam containing more or less gravel. Brown sandy loam containing much medium and coarse sand as well as gravel is generally found at 18 to 20 inches. This extends to 40 inches or more in depth. The area at Three Lakes is quite variable and the surface soil is frequently a silt loam, while in other places gravel appears at the surface. In Price County the soil frequently has a slightly reddish-brown color and often contains enough silt and clay so that it is sticky when wet. Silty spots similar to those at Three Lakes are also found in Price County, but none of the variations were of sufficient extent or importance to be separated on the map. Aside from the variations in texture there is a variation in topography and in Price County there is an area which might be called a low phase if of sufficient extent to map. The water table comes close to the surface so as to make it rather poorly drained. The color of this phase is a light gray or drab at the surface, and the subsoil is often mottled with brown, yellow, or drab.

Topography and Drainage.—The surface of this type is level to very gently undulating. In a number of places there are bowl-shaped depressions 50 to 100 feet in diameter and from 10 to 25 feet deep. These may occur singly or in groups, and are known as pits. Because of their limited extent and infrequent occurrence, they do not detract from the value of the land to any appreciable extent. The natural drainage of this soil is generally good, with the exception as referred to above where the water table comes closer to the surface than typical. The drainage is seldom excessive and the soil contains a sufficient amount of silt and clay so that it resists drought well.

Origin.—The material forming the Antigo fine sandy loam is alluvial in origin, and was deposited in the form of outwash plains by streams issuing from the ice sheet which covered this region. Most of the material undoubtedly came from the granitic rocks which

form the bed rock throughout this region. There is no calcareous material present and both soil and subsoil are in an acid condition.

Native Vegetation.—The Antigo fine sandy loam supported a growth of mixed hardwood, hemlock, and pine. In places the pine was the predominating growth, while in others hemlock and maple were the most plentiful. The pine was mostly large white pine with some Norway.

*Agricultural Development.**—Only a small proportion of this type of soil is under cultivation. The largest tracts of improved land of this class are in the vicinity of Three Lakes in Vilas County, and to the northwest from Phillips in Price County. Good crops of oats, barley, clover, corn, and potatoes are produced. Some rye and buckwheat are also raised. Yields of 150 to 250 bushels of potatoes are common; barley yields up to 30 bushels; oats from 35 to 50 bushels; clover 2 tons; and as much as 50 bushels of corn per acre have been secured, though it is not certain to mature every year. Grasses do very well even on land which has not been cleared except for the removal of the thickest brush.

This may be considered one of the most desirable soils of the area surveyed, although it is much more limited in extent than several other types. It is well adapted to a combination of small grain and potato farming. It is also well suited to general farming in conjunction with dairying, and it is along these lines that development is now being made. Alfalfa could be raised successfully on this soil if the acid condition were corrected by the use of lime. Liming would also help out the clover crop, especially on soil which has been under cultivation for some time.

SUPERIOR FINE SANDY LOAM—ROLLING PHASE

Extent and Distribution.—This soil comprises a total area of approximately 12 square miles. This is nearly all included in one body and is confined to the northern portion of Iron County bordering the south shore of Lake Superior and lying north of the D. S. S. A. Railway.

Description.—The surface of this type to an average depth of 10 inches consists of a brown to grayish-brown fine sandy loam which in places has a yellowish-brown color. The subsoil consists of a grayish to reddish fine sandy loam which becomes more sandy with depth. At from 24 to 30 inches a heavy compact red clay is encountered. The depth to the clay varies from 18 to 36 inches, but will average about 24 inches.

*For chemical composition and improvement see page 45.

Topography and Drainage.—A large portion of the surface of this type is nearly level, but it has been deeply cut by numerous ravines to such an extent that this condition will tend to retard agricultural development. Other portions have a rolling to hilly topography. Because of the surface features and the character of the upper subsoil, the natural drainage is good and but seldom excessive.

Origin.—The heavy red clay subsoil is doubtless of lacustrine origin, which has been modified somewhat by glacial action. The sandy covering doubtless owes its origin largely to glacial action. The parent material appears to have been sandstone. This sandy covering is usually slightly acid, while the heavy red clay subsoil is calcareous.

Native Vegetation.—The timber growth consisted chiefly of hemlock, maple, birch, and also considerable white pine. The greater part of the type has been cut over, and a second growth in which poplar is plentiful now occupies the land.

*Agricultural Development.**—Not more than one or two farms have been started on this type of soil, and so the crop data available is very limited. Because of the number of ravines and the resulting irregular surface, it is not nearly as desirable for farming purposes as the loam or clay loam of the Superior series. The soil in itself is well adapted to strawberries, bush berries, and the like; and apples and cherries should also do very well. Conditions of the soil and climate are very similar to the Bayfield region, and it seems, therefore, that as much of the type is within easy reach of shipping points that the development of the fruit industry might well be considered.

COLBY FINE SANDY LOAM

Extent and Distribution.—This type is confined to Price and Oneida Counties, and is of rather limited extent. The largest tract occurs in Town 38 N, Range 3 E, with smaller tracts southwest of Cranberry Lake, south of Dardis Lake, and in the vicinity of Sassons, Price County. In Oneida County most of the type is confined to the southeastern portion.

Description.—The surface soil of this type to an average depth of 10 inches consists of a light brown or gray fine sandy loam which is frequently mottled with yellow and rusty brown. The subsoil to a depth of 24 or 30 inches is a gray or drab fine sandy loam heavily mottled with yellow, rusty brown, and red. Below 24 inches the subsoil frequently consists of a clay loam or sandy clay which is very compact and is referred to as a hardpan. This hardpan strata fre-

quently extends to 36 inches and is usually underlain by unassorted sand and gravel which contains only very small amounts of finer material. Some gravel may be found throughout the soil section and also on the surface. The hardpan layer may be entirely lacking and in its place the fine sandy loam subsoil may extend to a greater depth than usual. Stones and boulders occur upon the surface and through the soil. They appear to be larger and more plentiful on the type as a whole as mapped in Oneida County than in Price County. In a few places the stones are sufficiently numerous to interfere with agricultural development. Two such areas of small extent are found in the southeastern corner of Price County, where boulders almost completely cover the ground. In some places there is a thin layer of peat or muck overlying the surface soil.

Topography and Drainage.—The surface of the Colby fine sandy loam is undulating to very gently rolling. It has a more nearly level surface than the Kennan fine sandy loam. Because of the surface features and the compact layer which usually occurs in the subsoil, the natural drainage is deficient over practically the whole type.

Origin.—This type of soil has practically the same origin as the silt loam, except that in this case there is probably no loessial material present. In general appearance the surface resembles the Antigo soils, but the Antigo series represents water-laid material, while this type is unassorted glacial debris derived from crystalline rocks. There is no calcareous material present and both soil and subsoil are strongly acid.

Native Vegetation.—The original timber growth consisted of maple, birch, and hemlock, with a considerable amount of white pine in places. Spruce, cedar, and tamarack are also found to a limited extent in the low places where the natural drainage is the most deficient. Most of the merchantable timber has been removed, and a second growth consisting largely of poplar, birch, alders, and willows has sprung up.

Agricultural Development.—But very little of this type of soil is under cultivation at the present time. Owing to its poorly drained condition, it is naturally cold and backward in the spring, and before the best results can be obtained some system of drainage is necessary for much of this land. When thoroughly drained the type will be fully equal in producing power to the Kennan fine sandy loam.

CHEMICAL COMPOSITION AND FERTILITY OF LOAMS AND FINE SANDY LOAMS

These soils are only a little more open in texture than the silt and clay loam types. They have a good water-holding capacity and will support very good pasture, but the somewhat higher percentage of fine sand which they contain reduces the water content of the surface somewhat so that they warm up more readily in the spring and have less tendency to bake and crack than the heavier soils. These qualities make them better adapted to such crops as corn and potatoes than are the heavier soils.

The total amount of the plant food elements, phosphorus and potassium, is nearly if not quite as large in the Kennan and Mellen fine sandy loams as in the Kennan silt loams. However, they have rather less organic matter and this together with the somewhat coarser texture results in a slower rate of chemical change by which the inert plant food of the soil becomes available to crops. For this reason the increase in the supply of active or fresh organic matter and the use of available plant food either in the form of stable manure or of commercial fertilizers becomes more important and especially when crops such as potatoes which are sold from the farm, and of which heavy yields must be grown to be profitable, are produced.

The increase in the supply of active organic matter is of the utmost importance. A high degree of fertility cannot be maintained in these soils unless about twice as large an amount of organic matter is developed in them as that which they originally have. The plowing under of legumes, such as a second crop of clover or a crop of soybeans, is the best method of securing this result. The application of phosphorus and potassium fertilizers can best be made for these crops, since it secures a much larger growth of these crops themselves and becomes available through their decomposition to the following crops of corn or potatoes.

These soils were derived from rocks devoid of lime carbonates and therefore have a marked tendency to become acid. The degree of acidity is usually only slight in the new soil, but increases as the land is cropped from year to year. This acidity does not affect the growth of most crops directly, but makes it more difficult to maintain a good degree of fertility. This is true because it is a condition unfavorable to the continued growth of the best legumes—clover and alfalfa. The slight degree of acidity does not interfere with the growth of clover while the soil is comparatively new, but does reduce the yields as the fertility is reduced by further cropping and even in the virgin condition on this soil acidity interferes with the growth of

alfalfa. It is also a condition unfavorable to the maintenance of a good supply of readily available phosphorus in the soil. These objections are probably not sufficient to make necessary the use of lime to correct the acidity on all of the land under cultivation for a number of years, but does make it desirable that farmers wishing to grow alfalfa should lime as well as inoculate the soil for this crop and also to watch the growth of clover carefully from year to year, so as to begin the use of lime on the fields as they are sown to clover as soon as it becomes difficult to secure a good stand.

These types of soils are well adapted to general farming and some special crops such as potatoes can also be grown to good advantage.

CHAPTER IV

GROUP OF MEDIUM SANDY SOILS

VILAS SANDY LOAM

Extent and Distribution.—This type of soil is one of the most extensive, if not the most extensive, in the area surveyed, it covering an area of over 700 square miles. It is found in all of the counties included within the survey, and within Vilas and Oneida Counties it occurs in practically every township. The various tracts range in size from less than one square mile to 15 or 20 square miles. In Iron County the type is more limited and is confined to the southern half of the county, beginning in the vicinity of Mercer and extending in irregular scattered tracts to the southwest. This same general belt continues on into Price County where it is more extensive. It is confined largely to the territory within 5 or 6 miles of the South Fork of the Flambeau River, and runs as far southwest as where the Elk River flows into this branch of the Flambeau. The greater portion of this soil in Price County is found along the south side of the Flambeau. In Ashland and Rusk Counties only a few scattered tracts are found.

Description.—The surface soil of the Vilas sandy loam to an average depth of 12 inches consists of a brown or reddish-brown medium textured sandy loam. The surface few inches usually contain sufficient organic matter to impart a slightly darker color, but the total amount of vegetable matter present is small, and the structure is loose and open. The subsoil consists of a yellow or yellowish-brown light sandy loam which becomes lighter in color and coarser in texture with increased depth until below 16 to 20 inches the material usually consists of coarse sand and small stones, with only a very small percentage of silt and clay. Some gravel is found in places and boulders are scattered more or less freely over the surface and through the body of the soil, but generally are not sufficiently numerous to interfere with agricultural development.

In texture this soil ranges from a loamy sand to a sandy loam, and there are some areas which in a detailed survey might be classed as gravelly sandy loam, but variations of this kind which were included

are limited and too irregular in occurrence for separate mapping at this time. Where the gravelly condition and the lighter texture extend over considerable areas the material was classed as Vilas gravelly loam. In Sections 29, 30, 4, 8, and 9 in Town 37, Range 9 E, Oneida County, the type is lighter in texture than usual. The same condition prevails in a belt beginning at Malvern and extending in a northeasterly direction along the east side of Pelican River, and beyond to a point two miles east of Starks. This material is too heavy for a sand, but is somewhat lighter than a typical sandy loam.

Along the south side of Town 35, Ranges 9 and 10 the Vilas sandy loam is heavier than typical, but the surface is quite rough and broken and the soil varies more than in some other sections, ranging from a sand to a silt loam within short distances. Taken as a whole, the material approaches more nearly a sandy loam than any other soil and was therefore included with that type.

Topography and Drainage.—The surface of this type varies from undulating to rolling with numerous limited tracts over which the topography is broken or rough. Where the rough and choppy tracts were of sufficient extent and gravelly they were classed as gravelly sandy loam. Over numerous tracts the surface is only gently rolling, and undulating tracts are not uncommon. Because of the uneven surface features and the loose character of the subsoil, there is usually no difficulty with the drainage of the type. Marshes are of frequent occurrence throughout the type, and along the margin of these where the land is low the natural drainage is frequently somewhat deficient. There are places where the drainage is excessive and where crops will suffer from lack of moisture. This is especially true over the crest of ridges where the gravelly material comes closer to the surface than usual.

Origin.—The material composing this type consists of glacial debris which was deposited chiefly in the form of ground moraine. The material was derived in part from the granite rocks underlying the region and in part from the sandstone rocks in Northern Michigan from which the material has been carried by glacial action. No calcareous rocks occur in this region and both soil and subsoil are found to be in an acid condition.

Native Vegetation.—The original timber was mostly large white pine with some Norway pine. This has all been cut and the pine stumps, with scattered birch stubs, are all that remain of the virgin timber. In some cases patches of hardwood timber are found on soil included with this type, especially on the heavier phase. The hardwood consists of maple, birch, some hemlock, and a little oak. These

grow chiefly in clumps in the pinery upon knolls of heavier soil, or on low areas where the water table is nearer the surface than usual. The cut-over pinery has in many cases grown up to poplar and birch ten to thirty feet high, with much cherry, alder, or scrub oak brush and small pine. The ground is frequently covered with a thick growth of sweet fern.

*Agricultural Development.**—Probably less than 3 per cent of this type is under cultivation at the present time. Where farms have been developed, however, very fair results have in most cases been secured. The usual crops grown and yields reported are oats from 30 to 50 bushels, potatoes 150 to 250 bushels, hay 1 ton, and corn 35 to 50 bushels per acre. Corn will not always mature but the above yields of ripe corn are not at all uncommon. Excellent silage can be produced practically every year. Clover does well and failures to secure a good stand appear to be infrequent. Garden truck also thrives on this soil, though trucking has not been developed except in the home gardens.

VILAS SANDY LOAM—ROLLING PHASE

Extent and distribution.—This type of soil covers approximately 150 square miles of territory. The largest tracts of it occur in Town 39, Range 9, Town 41, Range 9 in the country west and northwest of Eagle River, and in Town 38, Range 7 and Town 40, Range 7 to the south of Wind Pudding Lake, and north of Arbor Vitae Lake in Town 40, Range 6, also south of Crab Lake in Town 43, Range 6. This soil is quite generally distributed over Vilas and the northern part of Oneida County. In Price County there is also a small amount of this soil. The largest tract begins a few miles south of Fifield and extends in a northeasterly direction in a series of irregular areas of limited extent.

Description.—Beneath 1 or 2 inches colored dark brown by organic matter, the surface of this soil consists of 8 to 10 inches of brown, or slightly reddish-brown, sandy loam or loamy sand. Beneath this is a subsoil of loamy sand which is generally quite gravelly and stony at 16 to 20 inches. The surface of the soil varies from a loamy sand to a sandy loam, and there are a few places where the amount of fine material makes it approach a fine sandy loam. Gravel appears upon the surface and scattered through the surface soil in numerous places to a sufficient extent to class the whole type as a gravelly soil. In a few places a rather heavy sandy loam was included

*For chemical composition and improvement see page 55.

with the type such as that to the east of Arbor Vitae Lake, where the soil is a good sandy loam but extremely rolling. Stones and bowlders are generally more numerous on this soil than on the Vilas sandy loam.

Topography and Drainage.—The surface of this type is very broken and choppy or uneven, consisting of a series of sharp knolls and ridges with deep depressions intervening. Small marshes are common in the depressions. On the tops of the highest ridges areas of 5 to 30 acres of more gentle topography are included with this type. The type resembles in surface features the Vilas stony sand, but the texture is somewhat heavier, and stones are not so plentiful, making it a somewhat better soil.

Excepting in the pot holes and depressions the drainage on this soil is good or even excessive, due to its irregular topography and the loose open gravelly subsoil. The rolling, rough surface and the gravelly nature are the chief characteristics of this type of soil.

Origin.—The material making up this type was largely ground from granitic and sandstone rocks and deposited by glacial ice. The rough topography is due to the fact that it was deposited near the margins of the glacier where greater amounts of debris were accumulated and where more movement of it took place. The material usually appears as lateral or recessional moraines, as kames and eskers, and in part as rough ground moraine. No rocks of a calcareous nature have entered into the formation of this type and both soil and subsoil are in an acid condition.

Native Vegetation.—The timber on this soil was mainly large white pine with a few Norway pine in places. On other places maple, birch, and a few black oak are found scattered as individual trees among the pine stumps, or in clumps upon small knolls or ridge tops of more nearly level or heavier soil. Poplar, birch, cherry, maple, oak, and pine from 8 to 30 feet high are found forming the second growth.

*Agricultural Development.**—But very little of this soil has ever been cultivated and little or no crop data are available. The topography makes the laying out and cultivation of fields difficult, and no farms of any size or extensive settlements are found upon this kind of soil.

On the whole, this type must be classed with soils of low agricultural value, because of its rough uneven topography. While the texture and water-holding capacity are generally sufficient to place it with fair agricultural types, the rough, choppy, and hilly surface

*For chemical composition and improvement see page 55.

makes this soil undesirable farming land, so long as equally good and better soil with better topography remains undeveloped.

PLAINFIELD SANDY LOAM

Extent and Distribution.—The Plainfield sandy loam occupies a total area of about 25 square miles and is distributed through four of the counties included in this area. The greater proportion of the type is found in Vilas County where it occurs near Rest, Harris, and Clear Lakes, with smaller patches in Section 31 (Town 40, Range 7), Section 26 (Town 40, Range 11), and Section 12 (Town 39, Range 10). In Iron County it occupies several small tracts in the vicinity of Mercer and near Springstead Lakes. In Price County it occurs just west of Phillips and east of the Caro Resort on Pike Lake, both areas being small. In Oneida County the largest tract, and one which is being improved, occurs in the immediate vicinity of Starks.

Description.—The surface soil of the Plainfield sandy loam to an average depth of 10 inches consists of a brown sandy loam which has somewhat of a grayish-brown appearance in cultivated fields when dry. The subsoil consists of a yellowish-brown sand or light sandy loam usually containing considerable gravelly material, especially below 20 to 24 inches. The gravel is well rounded and interbedded with layers of coarse, medium, and fine sand in the lower subsoil. In places, as about Springstead Lakes in Iron County and near Starks in Oneida County, small stones from 1 to 3 inches occur upon the surface over local areas. In connection with these stony patches a surface layer heavier than above described and a coarser sand subsoil at 18 to 20 inches is often found. No bowlders or large stones are found upon the type, and most of the soil is free from the smaller stones described above.

Topography and Drainage.—The surface of this type is level to very gently undulating, and because of the open porous character of the subsoil the natural drainage is excellent and usually somewhat excessive. Variations in topography occur chiefly in the vicinity of marshes, lakes, and streams, but these are not at all pronounced.

A few small tracts were found where the water table was close to the surface, and in such places the natural drainage was deficient, and a mottled condition had developed in the subsoil; such instances, however, are seldom found.

Origin.—The material from which this type has been derived occurs in the form of glacial out wash plains. There is no calcareous

material present and an acid condition prevails throughout both the surface and the subsoil.

Native Vegetation.—The native forests on this type included quite a wide range. Most of the type was covered with white, Norway, and some Jack pine, though there are a number of tracts where hemlock, birch, maple, and some basswood were found. Over most of the type the original timber has been removed and the present growth is poplar and birch, with some small pines. Where the hardwood was found birch, cherry, poplar, maple, and hemlock now form the second growth.

*Agricultural Development.**—The greater proportion of this soil is still unimproved, but at several points considerable progress has been made in its development. One of these is northeast of Eagle River, known as the Saltenberger district, in Vilas County and another is in the vicinity of Starks in Oneida County. Excellent crops of clover, oats, barley, and potatoes are grown. On the new land clover generally makes a catch with very little difficulty and produces two cuttings in a season. Potatoes yield from 100 to 200 bushels per acre, barley 25 bushels, and oats from 30 to 50 bushels per acre. Corn, while often injured by late spring and early fall frosts, generally ripens if seeded early enough in the spring. Excellent corn for silage can practically always be grown.

PLAINFIELD FINE SAND

Extent and Distribution.—The Plainfield fine sand is an important and extensive soil in this area. There are approximately 195 square miles, the greater proportion of which is confined to Vilas and the northern half of Oneida County. Extensive areas occur in the vicinity of Eagle River in Town 40, Range 10; Town 40, Range 9, near Clearwater Lake in Town 39, Range 10; and near Three Lakes in Town 38, Range 11. Extensive tracts are also found in the vicinity of Minocqua, Woodruff, Arbor Vitae, and about Lac du Flambeau. Areas of smaller extent are found all through Vilas and the adjoining portions of bordering counties. Only one small patch was found in Price County and this occurs near Pike Lake.

Description.—Beneath two inches of grayish loamy fine sand to sandy loam the surface soil is a compact brown to reddish-brown loamy fine sand or sandy loam becoming yellowish sand or fine sand at from 10 to 16 inches. In some cases the fine subsoil is deep, containing no coarser material; in others the subsoil contains small gravel stones, becoming quite gravelly at 20 to 24 inches. Where

*For chemical composition and improvement see page 55.

gravel is present, the sand grains are generally of medium to coarse texture.

The type contains material of two somewhat different combinations, one being that of a fine sand containing slightly more silt and clay particles in the surface soil than the Plainfield sand; the other, while having still more silt and clay, also has a larger number of sand grains of coarser texture giving the soil a light sandy loam texture. These two textures were found so intimately associated that no attempt was made to separate them. The two are, however, of relatively the same consistency and both have better water-holding capacity than has the Plainfield sand.

Topography and Drainage.—The surface of the Plainfield fine sand is generally level with some slight irregularities in topography bordering streams, lakes, or marshes, due to erosion of the plain, and giving a slightly undulating topography in such places. Other small irregularities consist of small bowl-shaped depressions or pits which occur singly or in groups, and break the evenness of the topography to a greater or less extent. Generally the groups of pits are small and do not affect the topography over more than one or two forty-acre tracts where they occur.

This soil, like the Plainfield sand, has good drainage because of its open texture and loose and sandy subsoil, but excessive drainage or drought does not so easily occur because of the greater amount of fine material—silt and clay, in the surface 8 to 12 inches. This greater amount of fine material perceptibly increases the water-holding capacity of the soil as compared with the Plainfield sand. The difference can be noted in a greater compactness of the surface of the fine sand and the numerous pools of water which remain in the roads often for several days after a hard shower.

Origin.—The Plainfield fine sand is of alluvial origin and the material was deposited in stratified layers by water issuing from beneath the glacial ice sheet, as was also the Plainfield sand, the only difference being that due to a slower movement of the water, a greater amount of silt and clay or fine sand was deposited on the surface where this fine sand type is mapped. The parent material came largely from the crystalline rocks of the region, but there may also be incorporated some material which was carried by glacial action from the sandstone region along the shore of Lake Superior.

Native Vegetation.—The original timber growth consisted of pine, the majority of it being white pine with occasionally a smaller amount of Norway or large Jack pine mixed in. An exception to this rule occurs in Town 38, Range 4 East, where the level fine sandy soil is not well drained. Here numerous cedar, hemlock, and tam-

arack occur, and the general water table is near the surface. Some birch and a few maple trees are also found.

The second growth on this type where the original pine has been removed is a thick stand of poplar and white birch 10 to 30 feet high, with a greater or less proportion of young white and Norway pine. In places the young pine growth predominates over the poplars. The ground growth consists of ferns, brakes, and sweet fern, with some grass. A fair grass sod is often found established on the virgin soil where pastured and where moisture conditions are favorable.

*Agricultural Development.**—While but a comparatively small part of this soil has been farmed as yet, the Plainfield fine sand has more farmers on it than any other soil in the region where the type is found. The clearings range from small patches of 3 to 5 acres to large well developed farms with 40 to 100 acres of cleared land.

The settlements about Eagle River and Clearwater, comprising about 140 clearings or farms with approximately 2000 acres of cleared land, are largely on this kind of soil. The settlements about Woodruff and Minocqua, including about 75 clearings and farms with about 1500 acres cleared, are in large part on this soil.

The crops grown and yields reported are: potatoes 150 to 200 bushels; oats 30 to 40 bushels with yields as high as 56 in a few instances; barley 20 to 30 bushels; rye 20 bushels; peas 20 bushels; clover 2 tons in 2 cuttings, and corn about 40 bushels. Potatoes are well adapted to the soil and good yields are obtained. Oats also give good yields. Early varieties of corn while often retarded by a dry spell or a frost, mature well in most seasons if seeded early enough. Good silage can generally be secured. Clover does well and no great trouble in getting a good stand was noted, especially on new land.

VILAS FINE SAND

Extent and Distribution.—This is one of the types of minor importance since it is of very limited extent. Several small tracts are found south and east from Rhinelander in Oneida County and one area of about a square mile occurs about five miles southwest from Fifield in Price County.

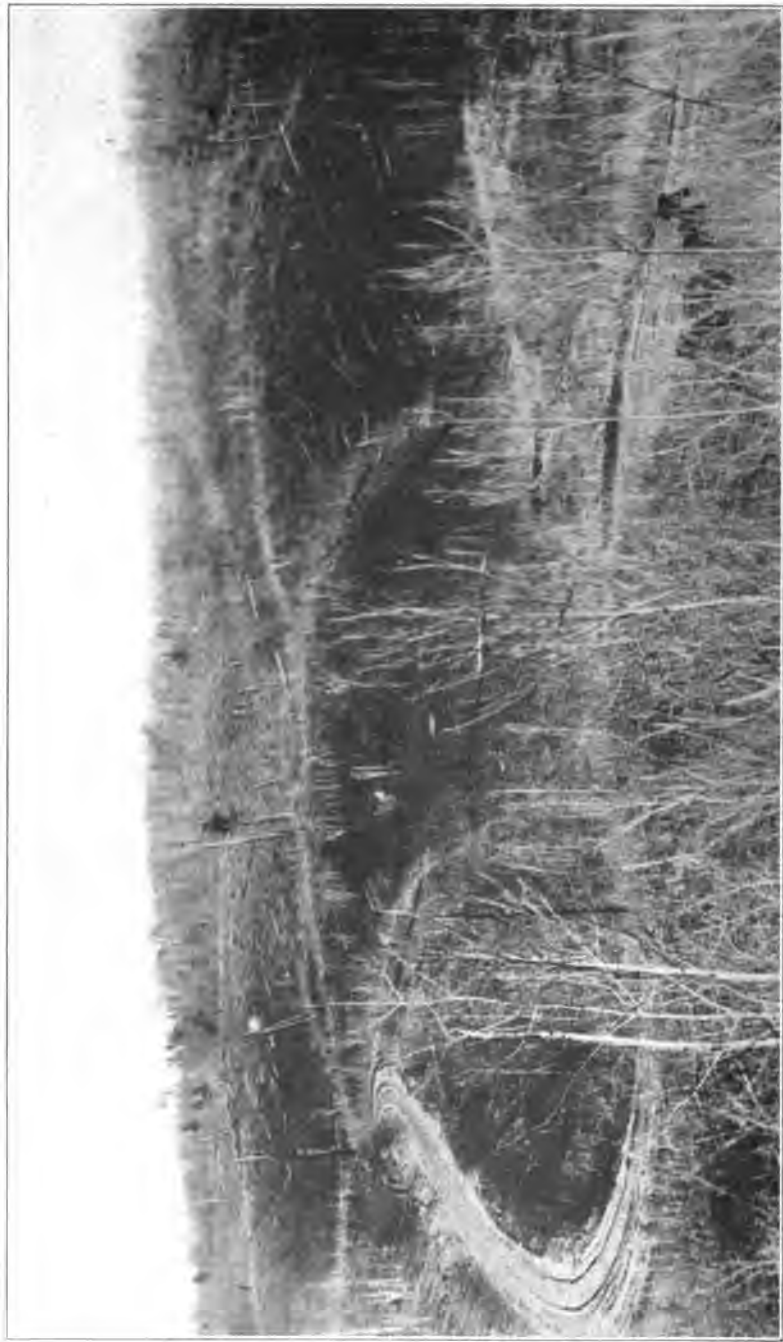
Description.—The surface soil to a depth of about 8 inches consists of a gray or yellowish fine sand which contains only a very small amount of organic matter. The subsoil consists of a fine yellow sand to a depth of over 3 feet. In some cases a small amount of gravel may occur through the subsoil, but as a whole the type is quite uniform.

*For chemical composition and improvement see page 55.



VIEW OF FARM ON PLAINFIELD FINE SAND NEAR WOODRUFF.

Shows crops of clover and corn obtainable on this soil.



VIEW SHOWING SURFACE FEATURES OF VILAS SAND AND VILAS STONY SAND.
These types of soil have a low agricultural value and present conditions seldom favor their improvement.

Topography and Drainage.—The surface of this soil is undulating to gently rolling, and because of the loose open character of the soil material the natural drainage is excessive, and the type is inclined to be droughty; though this soils retains the moisture better than the Vilas sand or stony sand.

Origin.—The material forming this soil has doubtless been derived through glacial action from the underlying crystalline rocks, and also in part from sandstone formations far to the north, from which the glacial ice carried varying amounts of material. There is no limestone in the region and the soil is in an acid condition.

Native Vegetation.—The original timber consisted chiefly of white and Norway pine, with a small amount of hardwood and hemlock in places. All of the pine has been removed, and a second growth of poplar, birch, some pine, and sweet fern now covers the ground where the land is not cleared.

Agricultural Development.—Because of its limited extent this soil is of little agricultural importance. Probably half of the type is under cultivation and fair yields of the usual farm crops grown are secured. With careful management clover, small grains, potatoes, corn and alfalfa can be grown with profit.

CHEMICAL COMPOSITION AND FERTILITY OF MEDIUM SANDY SOILS

These soils have intermediate texture and hence have moderate water-holding capacity. They are not fine enough to be especially well adapted to grasses for pasture, though a fair quality of pasturage can be secured on the heavier phases of these soils. The more deeply rooted crops, such as clover, rye, corn, and potatoes, find sufficient moisture during average seasons and suffer from drought only during periods of relatively low rainfall.

This moderate water-holding capacity permits these soils to dry off more quickly in the spring and become warmer than heavier soils, thus fitting them especially for such crops as corn, potatoes, and other truck crops requiring a warm quick soil. The water-holding capacity can be considerably improved by increasing the organic matter.

In chemical composition these soils are also of an intermediate character. The total phosphorus averages from 850 to 900 pounds in the surface 8 inches per acre. The total potassium of the surface 8 inches per acre is approximately 25,000 pounds or but little over one-half of that found in heavier soils such as the Kennan silt loam. The organic matter of these soils is also comparatively low, averaging from 2.5 to 3.0 per cent in the surface 8 inches and from 1 to 2

per cent in the second 8 inches. They have a correspondingly low nitrogen content averaging from 1000 to 1500 pounds in the surface 8 inches and from 500 to 800 pounds in the second 8 inches. This organic matter is largely in the form of leaf-mold and fine roots and is hence of an active character so that it decomposes quickly when the surface is first broken, furnishing a sufficient supply of nitrogen for a good growth of crops for a few years. But it is exhausted with comparative readiness and the most important point in the management of all of these soils is to follow methods which will maintain and increase the organic matter. In the virgin condition these soils are but slightly acid as a rule, but with continued cropping the acidity increases and for the best growth of clover and especially alfalfa, liming is essential. This use of lime not only makes the soil more suitable for the growth of alfalfa and clover, but assists in preventing the leaching of phosphorus and maintaining it in a form which is available for growing crops.

The management of these soils to maintain the fertility will depend to a considerable extent on the crops grown and on whether or not stock is maintained to which the produce of the farm is fed. When dairying or other live stock farming is practiced it will be less difficult to maintain the supply of the essential elements of plant food—phosphorus, potassium, and nitrogen. But even when stock is maintained, it is very probable that the moderate use of some form of phosphorus fertilizers will be found profitable, and some means for increasing the organic matter in addition to the use of the stable manure should be made use of as far as practicable. The growth of a crop of soybeans or clover occasionally all of which is to be plowed under as a green manuring crop will be found profitable in its effect on the succeeding crop of corn or grain.

When these soils are used for the growing of potatoes or other special crops to a considerable extent the use of commercial fertilizers containing phosphorus and potassium will be found necessary to maintain the soil at a point of productivity for a considerable number of years. Clover or some other legume must be grown regularly in the rotation to maintain the nitrogen and organic matter, and part or all of this should be plowed under. It is often desirable to use the commercial fertilizers containing phosphorus and potassium in order to secure a good growth of this clover, and there is little loss in so doing since essentially all of the phosphorus and potassium applied to the soil for the clover becomes available to the succeeding crop through the decomposition of the organic matter.

The use of lime in some form and also the inoculation of the soil is of the utmost importance when alfalfa is to be grown and will be

found helpful on the older fields even for the growth of medium red or mammoth clover.

While the use of commercial fertilizers containing phosphorus and potassium is desirable in the management of these soils it must not be considered that this is an indication that they have less value than heavier soils which are relatively higher in these elements for the growth of potatoes and other special crops. The fact that these soils become dry and warm early in the season makes them less subject to local frosts, and the finer tilth which these fine sands and sandy loams develop fit them especially well for the growth of potatoes and some other root crops, since they are practically free from checking and cracking. The cost of these fertilizers is a comparatively small part of the total cost of growing these crops. For further suggestions on the management of these soils and for information regarding source and use of fertilizers consult Bulletins 204 and 230 of the Wisconsin Experiment Station.

CHAPTER V

GROUP OF SAND SOILS

VILAS SAND

Extent and Distribution.—The Vilas sand covers a total area of about 100 square miles and is confined chiefly to Vilas and Oneida Counties, with a few scattering areas in the southeastern part of Iron County. Areas covering 3 to 5 square miles occur in Town 42, Ranges 7 and 8, and in Town 40 Range 5 in Vilas County. In Town 37, Ranges 5, 6, 7, 8, and 9, in Oneida County there are also numerous tracts of this soil, and numerous smaller areas are scattered through the southern portion of the country.

Description.—The surface of the Vilas sand is generally a grayish-brown medium or fine sand. The surface 6 to 8 inches are underlain by light yellowish-brown medium to coarse sand containing some gravel. The deep subsoil contains considerable coarse sand and fine gravel. Not much gravel and very few stones are exposed on the surface.

Topography and Drainage.—The surface of this type varies from undulating to gently and moderately rolling. On account of the generally loose open structure of the soil the natural drainage is excessive and the droughty condition is indicated by its bare appearance and general lack of timber or other vegetation.

Origin.—The soil of this type consists of glacial debris which was ground from the granite rocks underlying this district and from sandstone rocks farther north. No calcareous material has entered into the formation of this type and both soil and subsoil are in an acid condition.

Native Vegetation.—Most of the Vilas sand has a rather bare open aspect with but very little timber on it. Where timber occurs, it consists of small clumps of Norway and Jack pine or a stunted growth of poplar, scrub oak, and birch from 3 to 5 feet in height. Sweet fern and blueberry bushes grow plentifully on this soil. Not much grass or sod is found.

*Agricultural Development.**—Very little of the soil has been farmed. Some attempts have been made, but in many cases an abandoned

*For chemical composition and improvement of this soil see page 63.

clearing has been the result. The lack of fire wood, the liability of crops to suffer from drought, and low yields due to the quick dissipation of the small amount of organic matter under cultivation, all tend to discourage any permanent settlement on this type of soil at present. Where efforts to work this soil have been made the crops grown have been the same as are being grown on other soils, but yields have been low. During years when the rainfall is well distributed very fair yields have frequently been obtained, but the undertaking is too uncertain to insure even moderate success. So long as there are large tracts of better soil available, it would be unwise to attempt the cultivation of this soil, especially when the farmer's means are limited. The type would afford some grazing during spring and early summer, but because of the droughty condition the grass dries up with the first continued dry spell of summer.

VILAS STONY SAND

Extent and Distribution.—The Vilas stony sand is an extensive type in this region, but it is one of the lowest in agricultural value. It is confined chiefly to Vilas and Oneida Counties, with a small amount scattered through the southern portion of Iron County. It is very closely associated with the Vilas sand, and the line between the two is not always sharply drawn.

Description.—The texture of this soil varies somewhat. Rough topography and stoniness are the chief characteristics. Usually there are 8 to 10 inches of brown medium loose sand to loamy sand, containing much gravel which increases in amount with depth. At 18 to 20 inches a medium yellowish-brown sand is found which continues to a depth of 40 inches or more. The deep subsoil also contains considerable gravel and coarse sand, and stones are common through the soil section. Boulders large and small are scattered over the surface—in places very thickly. In fact, this type bears more stones and boulders than any of the other types mapped. The soil resembles the Vilas sand in texture, but differs from it in topography and stoniness.

Topography and Drainage.—The surface of this type is very uneven, rolling, rough, and broken. It consists of a series of sharp, pointed and choppy knobs and ridges interspersed with numerous pot holes, marshes, and small ponds. Many of the slopes are so steep that modern farm machinery could not be used even if the texture of the soil indicated a good agricultural value. On account of the rough broken topography and the loose open character of the soil and subsoil, the natural drainage is excessive and the soil droughty.

Origin.—The material forming this soil is largely derived from granitic rocks on which it lies and from sandstone rocks to the north. No calcareous material occurs in the soil and both soil and subsoil are in an acid condition.

Native Vegetation.—Much of the Vilas stony sand is nearly bare cut-over Norway and white pine soil. It supports a growth of sweet fern, scattered Norway, Jack, and white pine, or a sparse second growth of poplar and white birch. In the portions of slightly heavier soil a heavier growth of poplar and birch is found, and scattered clumps of hardwood from 1 to 10 acres in extent are frequently found.

*Agricultural Development.**—Very little farming has been attempted upon any area mapped as stony sand, and little or no crop data is available. In most cases where the land has been cropped at all, it has been only as garden spots or portions fenced off for pasture. No extensive farming operations have ever been undertaken. Because of its loose open structure, its rough broken topography, low organic matter content, and droughty condition, this soil must be classed as having a low agricultural value, even though the texture in places would in itself indicate a somewhat better grade of material. The stony condition in itself would make farming operations difficult, as in most cases modern machinery could not be used to advantage. Because of these conditions no attempts should be made to improve this soil so long as there is better land available.

PLAINFIELD SAND

Extent and Distribution.—The Plainfield sand comprises a total area of approximately 190 square miles and is found in four of the counties making up the present survey. It usually occurs in large tracts, each of which generally contains several square miles. Large areas are found in Vilas County extending south from Sayner through Town 40, Range 8 to the Wisconsin River in northern Oneida County. More of this soil occurs between Conover and State Line in Town 41, Range 10; Town 42, Range 10; and Town 42, Range 9. It is found south of Crawling Stone Lake in Town 40, Range 5, west of Trout Lake in Town 41, Range 6, and Town 42, Range 6, about Bowlder Junction in Town 42, Range 7, and about Rest Lake in Town 42, Range 5 and Town 42, Range 4. In the southern part of Oneida County there is a very extensive area in Town 36, Ranges 5 and 6. The Tomahawk River flows through this tract. A tract several square miles in extent occurs in northeastern Price County in Town 40, Range 3 East. Smaller tracts of from $\frac{1}{4}$ square mile

*For chemical composition and fertility of this type see page 63.

to over one square mile are found scattered throughout the general region in which are found the larger areas of this soil.

Description.—The surface soil has from 1 to 2 inches of grayish medium to fine sand resting upon from 8 to 10 inches of medium brown or yellowish-brown sand. Yellow medium to fine sand is often found at 10 to 12 inches and this may extend to 40 inches or more, or may be followed by a medium coarse sandy layer containing varying amounts of gravel at 24 to 30 inches. Where the gravel layer is present it is underlain by a layer of coarse yellow sand. The type as a whole is stone free and is quite uniform. The chief variation is where the water table is closer than usual to the surface and more organic matter is present in the surface few inches than typical. Slight variations also occur in texture, but these are of small extent and not sufficient to justify the establishing of phases. North of Conover in local areas the texture is finer than typical, but the character of the vegetation and water-holding capacity does not differ from the Plainfield sand; therefore, no separation was made.

Topography and Drainage.—The surface features or topography of Plainfield sand consists of a level generally unbroken plain. Some variations occur in small areas where the plain is pitted—that is, having a group of bowl-shaped depressions. In other places broad gentle undulations occur, and about marshes, lakes, and along streams there are some irregularities, but in the largest areas the topography is a level plain.

Because of the open rather loose structure the natural drainage is good and often excessive. In some places the surface attains a certain compactness, but the general looseness of the subsoil permits the rapid percolation of all rainfall. The effect of this excessive drainage is seen in the quick drying of the soil and lack of water puddles after a heavy rain. The vegetation also shows the effect—the trees, if any, being drought-resisting varieties and the plant vegetation of a kind that requires a minimum amount of moisture. The difference in the resistance to drought between the Plainfield sand and Plainfield fine sand is noticeable in the vegetation, the latter generally bearing larger timber with a greater percentage of white pine, with plenty of poplar and birch appearing in the second growth.

An exception to this general state of excessive drainage is found on the areas bordering the Manitowish marshes between Powell and Manitowish. Here the type consists of bare flat sand areas but slightly elevated above the peat marshes where the water table is so near the surface that the soil is more or less continuously wet and

numerous wet grass grown swales and flats are scattered over the sand areas. These areas cover about 2 to 3 square miles of territory in Sections 8, 13, 15, 16, 17, and 21 in Town 42, Range 4 East. Another low poorly drained area is found in Oneida County in Sections 4 and 5 in Town 37, Range 8 East, where the water table comes from $1\frac{1}{2}$ to 2 feet from the surface of the ground and the timber consists of hardwood and pine.

Origin.—The Plainfield sand has been deposited as outwash plains by water coming from beneath the glacial ice sheet. The material was doubtless largely derived from the granitic rocks upon which it lies, and in part also from the Keweenaw sandstone farther north. Being assorted by water from the melting glacier, the finer material was largely carried away, leaving the heavier sand grains deposited in horizontal layers. This horizontal stratification may be noted in almost any pit or road cut in this kind of soil. There is no calcareous material present and both soil and subsoil show varying degrees of acidity.

Native Vegetation.—The original timber growth on this soil consisted largely of Norway and Jack pine often of large size, with some white pine in places. Extensive areas appear to have had no timber on them for a long time past, as no stumps or other signs of timber are to be seen. Woodmen also report that when the timber of these plains was first cut, there were open areas bare of timber in some places. The second growth, where any has escaped the repeated fires, consists mainly of small Jack and Norway pine. Poplar and birch second growth is absent or meagre. The ground cover consists of sweet fern, brake, and blueberry bushes, with some short coarse buffalo grasses in places. In Sections 4 and 5, Town 37, Range 8 East, in Oneida County there is a somewhat heavier occurrence of this soil which is low lying and over which there was a mixture of hardwood and pine.

*Agricultural Development.**—Only a small proportion of this soil is cleared and under cultivation at the present time. The largest improved tract is in Oneida County in Town 30, Ranges 5 and 6. The yields reported from this region are corn from 20 to 40 bushels, rye from 10 to 15 bushels, buckwheat 15 to 18 bushels, hay about 1 ton, and potatoes from 100 to 150 bushels per acre and frequently more. Corn will not always mature, but is nearly always certain to provide silage.

*For chemical composition and improvement see page 63.

COLOMA SAND

Extent and Distribution.—This type occupies a total area of approximately 12 square miles and is all confined to the extreme northwestern portion of Iron County. Most of it occurs in one solid body and there are only a few detached areas. One of these is located at Gurney.

Description.—The surface soil of this type to an average depth of 8 inches consists of a yellowish-brown sand of medium texture. It is loose and open in structure, and contains only a very small amount of organic matter. The subsoil consists of a yellow or light yellow medium incoherent sand which becomes somewhat coarser with depth. There is no gravel on the surface and but very little in the soil or subsoil.

Topography and Drainage.—The surface varies from gently rolling to hilly, and because of the loose open character of the soil and subsoil the natural drainage is excessive and the soil droughty.

Origin.—The material forming this type consists of glacial debris which has been ground from the underlying Keweenawan sandstone by the action of glacial ice. There is no calcareous material present and both soil and subsoil are in an acid condition.

Native Vegetation.—The original timber growth consisted of white and Norway pine. All of this has been removed, except on the Indian Reservation. Fires have run over the country at various times, and now the region presents a rather desolate forsaken appearance.

Agricultural Development.—But little has been done in the way of improving this soil, and its development will doubtless be delayed until a larger proportion of the better soils in the region have been taken up. The type has a low agricultural value and will require very careful management to produce profitable crops from year to year.

CHEMICAL COMPOSITION AND FERTILITY OF COLOMA, VILAS, AND
PLAINFIELD SANDS

In some respects sandy soils have advantages over heavier soils. They become drier and therefore warmer and can be worked earlier in the spring and more quickly after rains than heavier soils. These advantages are particularly important in regions of short growing seasons, but when the soil is too sandy it does not hold sufficient water from one rainfall to another to satisfy the needs of growing crops and they therefore suffer from drought. Moreover, some sandy soils are lower in their supply of the chemical elements

demanding by crops than heavier soils. When these two factors become too low they limit the profitable farming of these soils. In the mapping of the Soil Survey those soils which are classed as fine sands or sandy loams, have fairly good water-holding capacity and when their fertility is properly maintained their good qualities in regard to warmth and earliness can be taken advantage of, and they can be farmed with profit. But soils which are classified as sands, such as the Coloma, Vilas, and Plainfield sands, are so coarse as a rule that they do not have sufficient water-holding capacity and their use for the growth of staple crops is ordinarily unprofitable, unless unusual skill is used in their management. It must be kept distinctly in mind, however, that all types as mapped show some variation in texture or fineness of grain and that on small portions of soils mapped as sands a more detailed mapping would often show fine sands. This is particularly true in the case of sands mapped as Plainfield sand in Marinette County which was surveyed several years before the remainder of the area was mapped. The discussion of the composition and agricultural value of fine sands will be found on page 55. With very unimportant exceptions, the soils mapped as Coloma, Vilas, and Plainfield sands in this area are of a very sandy character and profitable farming will be possible on them only when they are managed with unusual care and the crops to which they are best adapted are grown. The chief factor limiting their agricultural use is that of water-holding capacity. This depends chiefly on the texture or fineness of grain and cannot be affected by any treatment it is practicable to give them. The water-holding capacity can be somewhat increased by increasing the amount of organic matter, but this is a comparatively slow process and the amount of organic matter it is practicable to develop and maintain in these soils will increase their water-holding capacity only to a limited extent.

The total content of the essential elements of plant food in these soils is moderate. The total phosphorus in the surface 8 inches per acre averages between 1000 and 1100 pounds and in the second 8 inches between 600 and 700 pounds. The total potassium in the surface 8 inches per acre is approximately 35,000 pounds in comparison with 50,000 or 55,000 pounds in the silt loam soils of that region. The total nitrogen content is between 1200 and 1400 pounds in the surface 8 inches per acre. When a sufficient supply of active organic matter is developed in these soils a portion of the phosphorus and potassium will undoubtedly be made available, but the use of fertilizers containing these elements in a more readily available form is desirable whenever these soils are farmed; especially is this true in

the case of garden or truck crops which make larger demands on the supplies of these elements than do the staple crops.

The starting point in the improvement of these soils is the development of active organic matter through the growth of legumes which are able to secure their nitrogen supply from the atmosphere. The growth of a good crop of mammoth clover or soybeans through the use of mineral fertilizers containing phosphorus and potassium is the best means of supplying this nitrogen and organic matter. This crop should be plowed under as a green manuring crop. Ordinarily on these soils clover should be sown without a nurse crop. It should also be put in a little deeper than on heavier soils and the drill should be followed by a roller, and finally the drag or corrugated roller should be used.

By the adoption of a rotation of crops including one year in four in which a legume crop is grown and the entire crop plowed under and the use of moderate amounts of commercial fertilizers containing phosphorus and potassium together with proper attention to cultivation to conserve moisture fair, crops can be grown during the remaining three years. When dairying or any other line of stock farming is followed so that most of the crops grown aside from the green manuring crop are fed, the fertility of this land can be maintained. This will permit the growth of potatoes or other truck crop for direct sale on approximately one-eighth of the land on the farm.*

* Extensive experiments have been carried on on Plainfield sand near Sparta. Information on these may be secured by writing to the Soils Department of the Wisconsin Experiment Station.

CHAPTER VI

GROUP OF POORLY DRAINED SOILS

PEAT

(With Included Areas of Muck)

Extent and Distribution.—Under this classification has been included all varieties of swamp and marsh land in this region whose surface soil is of organic origin. The total area covered by this class of land exceeds 600 square miles. Peat soils are well distributed throughout the area and occur in varying amounts in practically every township. It occurs as low lying areas bordering streams and lakes, in depressions and valleys between rolling ridges and hills where outlets are frequently lacking, or as wide extensive marshes which are wet the greater part of the year and have accumulated a surface covering of Peat in varying stages of decomposition.

The wooded marsh land occurs chiefly along streams and in smaller depressions in nearly every township, but the most extensive open peat marshes are confined to three or four localities. These most extensive tracts are known as the Thunder Lake or Three Lakes Marsh in Towns 38 and 39, Range 10 East; the Swamp Lake Marsh in Towns 38 and 39, Range 8 East; the Flambeau Marsh three miles north of Lac du Flambeau station in Towns 41 and 42, Range 5, and the Manitowish Marshes which cover extensive tracts bordering the Manitowish River and its tributaries in Town 41, Ranges 3 and 4, and in Towns 42 and 43, Range 4 East. Each of these marsh districts comprise from 15 to 25 square miles, each of low wet peaty lands. Smaller but important areas of Peat are found in all of the counties in the survey. The section in which the marshes are the least extensive is in the southwestern portion of the area in the southern part of Price and the eastern part of Rusk Counties where the Colby soils predominate.

Topography and Drainage.—All the marsh and swamp lands are necessarily nearly level. The drainage is poor due to the lack of a surface outlet or because of a dense subsoil layer which prevents the water from seeping away through the porous subsoil. Some of the large marshes have indications of once having been large lakes since

glacial times, which have found outlets more recently and have been partially or completely drained of their surface water. The Flambeau and Three Lakes Marshes appear to be of this origin, the lower lying portions of these marshes still containing large shallow lakes. The drainage conditions on all of the marshes are such that no agricultural development can be made until some system of drainage has been installed. After deep outlet ditches and laterals from 40 to 80 rods apart have been put in to remove the surface water the land can be cleared and broken during dry seasons. But in most cases either open ditches or tile will have to be put in every 10 to 20 rods to make the growing of hay safe and even closer to drain the land sufficiently for other crops.

Description.—The material composing this type consists of decaying vegetable matter in varying stages of decomposition, with which there has been accumulated varying amounts of mineral matter. The typical peat contains only a small amount of mineral matter and is often of a brown color and fibrous texture, though it may also be black and thoroughly decomposed. Around the margins of the large marshes and frequently making up the entire body of smaller marshes, the material contains sufficient mineral matter so that it could be properly classed as Muck. Such tracts, however, have a limited extent and in a general survey it was not considered practicable to attempt a separation. The mucky phase is also found along streams where it occurs in a narrow belt, usually wooded.

The typical Peat in the large marshes extends to a depth of 3 to 10 or more feet, and is often so loose that a pole can be shoved down to these depths. Over small tracts which might be classed as shallow peat, the depth ranges from 10 to 24 inches, but it was also impossible to separate these variations in a general survey. In a few of the large marshes some shallow peat was also found, especially in Vilas County. When the shallow peat is cultivated it is probable that the underlying material may become thoroughly mixed with the peaty covering and form a sandy or loamy Peat.

The underlying material varies greatly, depending largely upon the texture of the upland soils adjoining the marshes. In the regions where most of the soils are sandy, the material underlying the marshes is quite generally sandy, sometimes having a hard compact layer several inches thick which is often referred to as a hardpan. In regions where the upland soils are largely silt loams or loams, the material beneath the marshes is usually heavy.

Many of the grass marshes have been burned over repeatedly in dry years; others have been flooded by rising waters from adjacent streams and more or less mineral matter mixed with the peat. The

burning and addition of mineral matter has produced a finer, denser, and more decomposed surface soil which approaches a Muck in texture.

This sort of soil is found on the Haymeadow Creek Marshes near Conover, and also over parts of the marsh bordering Mud Creek just west of Powell in Town 42, Range 4, where a good heavy compact muck is found in places. The best marsh soils were generally found on the grassy marshes, being best where blue-joint grass was found, with somewhat less mineral matter and less depth where wire grass grew. Thinly wooded and blueberry marshes which have not been burned over usually have a covering of sphagnum moss and the peat from this source is coarse and stringy like excelsior and very raw. In some of the marshes small islands were found which were too limited in extent to be indicated on the map. Such a condition appears in Section 4, Town 36, Range 5 East, and Sections 32, 33, and 34 in Town 37, Range 5 East in Oneida County. A few other instances were observed where this same condition prevailed, though to a smaller extent.

As there is no calcareous rock formation in this region the adjacent upland soils are all acid, and consequently the waters coming into the marshes and the peaty material itself is always found to be acid. But this acidity in peat will in part be gradually removed by thorough drainage.

Native Vegetation.—Where protected from fire, partially due to their being lower and less often dry even in dry years, the open marshes bear sphagnum moss and patches of blueberry and cranberry bushes. Such marshes are generally partly wooded. Scattered clumps of stunted black spruce six to twelve feet high may be found with a dense growth of tamarack, cedar, alder, and spruce around the margin of the swamp. Other swamps are entirely covered with a dense growth of tamarack and cedar 20 to 60 feet high. The open marshes, where the Peat is not too deep and there is no moss, have often grown up to wire grass, which has a small round stem 16 to 20 inches high. Where the marsh soil is heavier and approaches a muck, blue-joint grass is apt to be found. This is a taller grass—2 to 3 feet high—with a feathery tassel, and it makes much better hay for feeding purposes than the wire grass.

Agricultural Development.—Very little of the Peat has been drained and put into farm crops. In Section 34, Town 42, Range 10, near Conover, a portion of a marsh was ditched, plowed, and seeded to timothy during a series of dry years and yielded fine crops of hay for several years. This marsh, however, has now gone back to wire grass and blue-joint due to a return of wet conditions. Buckwheat

has been grown on a part of the Three Lakes Marsh. The Three Lakes Marsh and the Swamp Lake Marsh contribute large quantities of wire grass. Farmers cut it for hay, and much is baled and shipped to grass rug and carpet concerns in Green Bay and Oshkosh. Large amounts are also obtained from the Flambeau Marsh.

Agricultural development on these marsh lands, however, cannot be developed to any proportions until drainage systems have been installed. Many of the marshes have sufficient fall so that their drainage would be possible. The larger ones, of course, would require a large expenditure, and the organization of extensive drainage districts. There are numerous small marshes which could be drained at comparatively small cost, and where the surrounding upland is improved these marshes should be drained.

CHEMICAL COMPOSITION AND FERTILITY OF PEAT

The chief difference between peat soils and upland soils consisting largely of earthy matter, is that they have relatively small amounts of the mineral elements phosphorus, potassium, calcium, and magnesium, and have extremely high amounts of nitrogen in the organic matter. The average per cent of phosphorus in the peats of this region so far analyzed is 0.135 per cent. This means that in an acre of soil to a depth of a foot there is approximately only 675 pounds or in 2 feet 1350 pounds in comparison with upland soils which have approximately twice these amounts. Moreover, the acid condition of these soils renders the phosphorus less available than in non-acid soil.

The deficiency of potassium in these soils is greater than that of phosphorus. They contain on the average 0.3 per cent of this element, while good upland clay loam soils average 2 per cent or over six times as much expressed in percentage. When the greater weight of the upland soils is taken into account it will be found that they contain in the upper two feet 120,000 pounds per acre, while the peat soils contain but 3000 pounds.

A large amount of organic matter in these soils gives them an extraordinary amount of nitrogen. They average 2.5 per cent of this element, while the upland silt loam soils of this region contain but about 0.12 per cent and this only in the surface 8 inches—the amount in deeper layers being much less.

As a result of this difference in the chemical composition the peat soils are very unbalanced. Their rational treatment requires the use of fertilizers containing especially the elements phosphorus and potassium. Of course, these elements are contained in relatively

small amounts in barnyard manure and good applications of manure will secure good yields of crops on peat soils, but manure contains large amounts of nitrogen not needed by the peat, so that when a farm includes upland soils as well as peat, the manure should be used on the upland soils and commercial fertilizers containing phosphorus and potassium used on the peat land.

On the deeper peats which are in a very raw and acid condition the use of lime in some form in addition to the commercial fertilizers will be found profitable. Occasionally a marsh is found on which on account of coldness and high acidity at first nitrification or the chemical change by which the nitrogen in the organic matter becomes available to crops does not take place readily and the use of a light application of composted stable manure to inoculate the soil with the proper organisms is very helpful. In this part of the state the chief crop grown on marsh land should be grass for hay.

WHITMAN SILT LOAM

Whitman silt loam is of very limited extent and of rather minor importance. It is confined to all lands chiefly associated with Colby soils, and is found most largely along stream courses or in depressions which are poorly drained. A number of small areas occur in the southern part of Price county where the Colby silt loam predominates. Probably the largest tracts are found in Oneida county, one occurring in the extreme southwestern corner and another in the southeastern portion of that county.

This type of soil is quite similar in texture and structure to the Colby silt loam, but it differs from that type in its topography position and by containing a larger amount of organic matter in the surface soil. The surface of this type to a depth of from 8 to 10 inches consists of a dark gray, brown or black heavy silt loam which is underlain by a bluish or drab strongly mottled silty clay loam which usually extends to a depth of over three feet. In some places the lower subsoil contains a sufficient amount of sand and fine gravel to impart a gritty feel. The dark color of the surface is due largely to the accumulation of organic matter. The amount of organic matter is quite variable which accounts for the variation in the color of the surface soil. In a number of places there was found a very thin covering of muck or peat over the surface of this type. Some of the areas mapped are somewhat stony. The area east of Pelican Lake in Oneida county is quite shallow the underlying rock outcrops in a number of places, and there are numerous large boulders upon the surface.

The surface of the Whitman silt loam is level to very gently sloping, and because of its low position and the heavy character of the soil material, the natural drainage is very deficient. It is probable that all portions of this type will require artificial drainage before cultivated crops can be grown successfully.

The original timber on this land was quite similar to that on the Colby silt loam, but there is probably a somewhat larger amount of elm, with some ash and smaller amounts of maple and birch.

But very little of this type is under cultivation at present, and before agricultural operations can be successfully carried on it will be necessary to provide thorough drainage. Open ditches and tile drainage may both be used to advantage in reclaiming this soil. When thorough drainage has been established, this land will be adapted to a wide range of crops and will be fully equal in producing power to the Colby silt loam.

GENESEE SANDY LOAM

The surface soil of the Genesee sandy loam to an average depth of 10 inches consists of a gray sandy loam of medium texture, underlain by a drab or gray medium sand grading into stratified beds of sand and gravel. The subsoil is frequently mottled, but this mottling is the most common where a small amount of clay is mixed with the sand. The surface of the type is frequently covered with from 1 to 10 inches of peat or muck, and as a whole the type is subject to considerable variation.

The Genesee sandy loam is of very limited extent and does not occupy more than one square mile, all of which is within Price County. The largest area is found to the southeast of Fifield, within the flood plain of Sailor Creek. A small tract is also found in the northeastern portion of Price County about 2 miles west of Round Lake. The soil here is somewhat lighter in texture than typical. Another small area occurs near Phillips just west of Elk Lake within the flood plain of Elk River. The soil here is somewhat finer in texture than typical for a sandy loam.

As this soil is low, poorly drained, and subject to annual overflow it is not well adapted, in its present condition, to the production of cultivated crops. If cleared it could be used for pasture.

ROUGH STONY LAND

This classification includes land which is so rough, broken, or rocky that it is of little or no value as agricultural land. It has a total extent of about 10 square miles and is confined to the northern portion of Iron County, and forms a part of the Iron Range. The largest tract starts about $2\frac{1}{2}$ miles northwest from Hurley and extends to the southwest as a narrow belt for about 10 miles. This tract is extremely rough and broken, and consists for the most part of huge rock outcrops. Between the rocks and along lower slopes there is often a thin covering of soil which would provide some pasture. The slopes are too steep, however, to permit the land to be cultivated and the soil is always shallow. In the vicinity of Kimball there are several smaller tracts where the surface is level to undulating and consists of a mass of broken rock. Sometimes there is a very thin covering of soil, but usually rocks are exposed over the greater portion of the surface.

The tree growth over the whole type is limited, and usually stunted, though where the soil is the deepest fair sized timber grew. The chief growth was maple and birch. Poplar forms most of the second growth.

Because of the extremely rocky nature of this material no attempts are made to cultivate it, and such land may be considered as non-agricultural.

CHAPTER VII.

AGRICULTURE AND CLIMATE

CROPS AND SYSTEMS OF FARMING

The staple crops for this region are timothy and clover for hay, oats, and potatoes. Wheat, barley, early varieties of corn, alfalfa, and root crops are grown to some extent. Since stock can be pastured on partly cleared land before it is practicable to use it for any other purpose, stock raising and especially the dairy industry, is particularly adapted to that region. Potatoes is the most important special crop and is grown chiefly on the lighter soils such as the sandy loams and fine sandy loams. The maintenance of fertility on farms on which potato growing is the chief industry can best be accomplished through the maintenance of some stock and this also employs the farmer's time during the winter to advantage.

The following table shows the acreage of the most important crops as published in the United States Census Report for 1910.

County.....	Iron	Oneida	Price	Vilas
Approximate area in square miles.....	786	900	1241	907
Percentage of land improved.....	0.78	3.0	2.8	0.86
Hay and forage Acres.....	1916	5860	12790	1547
Yields in tone ..	2461	8040	18475	1747
Oats Acres.....	311	2659	1450	550
Yields in bushels	9044	74501	46033	15873
Barley Acres.....	47	270	420	60
Yields in bushels	636	5277	10471	1255
Wheat Acres.....	88	83	65	36
Yields in bushels	1537	1248	1165	517
Rye Acres.....	11	155	128	41
Yields in bushels	124	2278	2473	574
Corn Acres.....	18	115	81	20
Yields in bushels	747	2910	3357	831
Potatoes Acres.....	201	1404	1059	332
Yields in bushels	26408	163241	155654	39039
Peas Acres.....	45	99	101	27
Yields in bushels	572	1663	2228	641

Vegetables for home use are readily grown, including practically all kinds commonly grown in the state. Small fruit, including raspberries, blackberries, and strawberries do exceptionally well throughout this region. Hardy varieties of apples, plums, and cherries can also be grown, although this cannot be considered a fruit section with the possible exception of the northern end of Iron County where the lake affects the climate favorably.

CLIMATE*

Among the factors which influence the agriculture of a state none is more important than climate. The class of crops which can be grown is largely determined by the length of the growing season, and the amount and distribution of the rainfall. Any one of these factors may determine the type of farming which can be followed to best advantage.

The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation having a range of from 28 to 34 inches, while the mean for the state as a whole is 31 inches.

The local distribution of rainfall varies, however, from year to year in different sections. The variation is caused largely by the movement of cyclonic storms. The average rainfall for the entire state during the driest year was 21.4 inches, and for the wettest year 37 inches.

Of equal importance in agriculture to the total rainfall is its seasonal distribution, and in this respect Wisconsin is unusually fortunate, since about half of the total rainfall comes in May, June, July, and August, and nearly 70 per cent from April to September, inclusive. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches, and May 3.9 inches. The average rainfall for the State during winter is 3.9 inches, during spring 8.3 inches, during summer 11.4 inches, and during autumn 7.4 inches. The small winter precipitation in Wisconsin, mostly in the form of snow, on the other hand, causes virtually no leaching of fertility from the soil or erosion.

Based upon the factors of latitude, altitude, and lake influence, chiefly affecting temperature and the length of growing season, Wisconsin may be divided into eight climatic provinces. The area surveyed lies within two of these, known as the Superior Shore and the Northern Highland. By far the greater proportion of the region surveyed is included in the Northern Highland. This province covers most of the northern part of the state north of Marathon County,

*For further information on the climate of the State see Bul. 223 on the Climate of Wisconsin and Its Relation to Agriculture, from which this data has largely been taken.

AGRICULTURE AND CLIMATE.

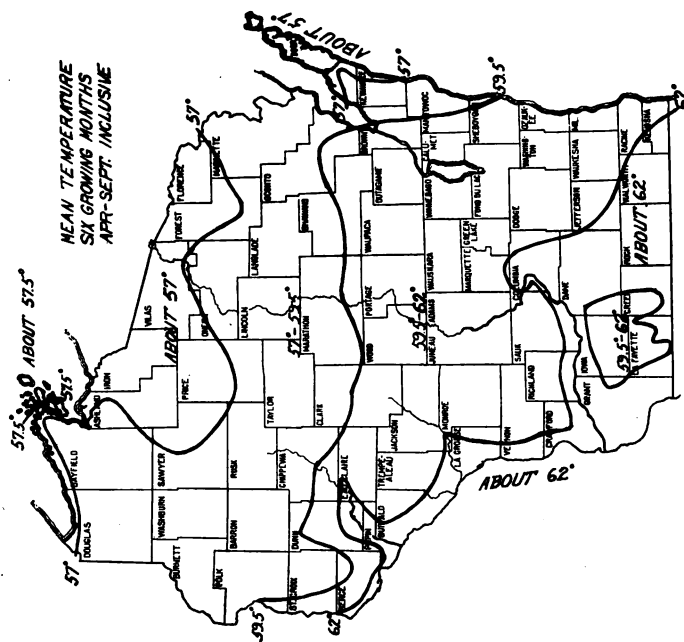


Fig. 3. Map showing average temperature for the six growing months April to September, inclusive. Note that the difference between the average temperature for the areas surveyed, and the southern portion of the State is only slight, varying from 2.5 to 5 degrees.

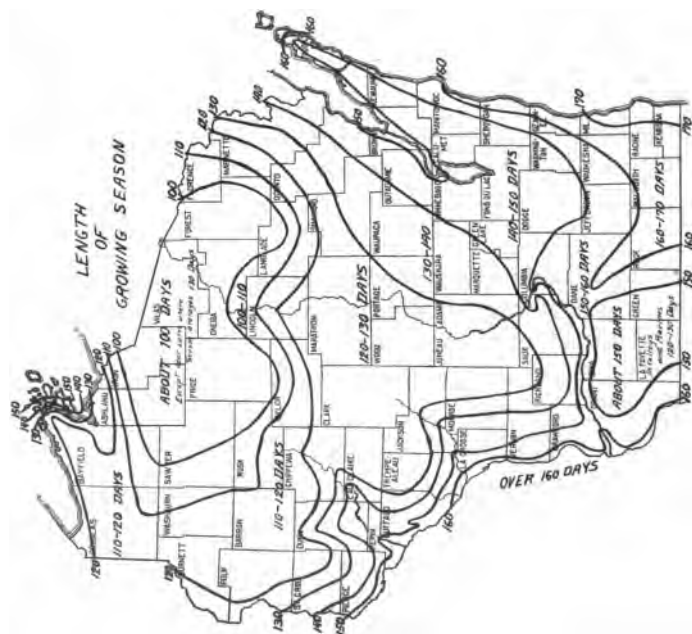


Fig. 2. Map showing length of growing season for corn.

including the head waters of the Wolf, the Wisconsin, and the Chippewa Rivers, together with smaller streams flowing into Lake Superior and Lake Michigan. This region is characterized by a short growing season, cold winters, warm summer days, and cool summer nights.

The northeastern portion is cooler than the southern and western, the growing season averaging about 100 days in Vilas County, as compared with 130 days in Marathon and 120 days in Burnett County. Near the small lakes which abound in this portion of the state the growing season is lengthened several days. Away from these lakes, in these northern counties, light frosts are likely to occur upon low land in any month of the year.

The area surveyed borders Lake Superior for a distance of less than 10 miles, so that but a small proportion of this region falls within the Superior Shore Province. The climatic conditions, however, are noticeably different from those prevailing throughout the Northern Highland region. The Superior Shore consists of a narrow belt adjoining Lake Superior of unknown width, though it is unlikely that the lake influence extends farther inland than twenty-five miles and apparently, as a factor of horticultural value, this distance is considerably less. There also appear to be great variations within this belt.

Generally, on about four winter mornings, the temperature drops to 20° below zero or lower; while on an average of five days in summer it reaches 90° or more. The average length of the growing season varies. Immediately along the shore it is about 130 days, diminishing to about 115 days 10 miles inland.

FROST DATA

The following table gives average dates of killing frosts and approximate length of the growing season at various stations within and adjacent to the area surveyed.

Station	Length of Record Years	Average date of last killing frost in spring	Average date of first killing frost in fall	Approximate length of growing season Days
Ashland.....	16	May 14	Sept. 21	130
Butternut, Ashland County...	15	June 4	Sept. 9	97
Prentice, Price County.....	17	June 6	Sept. 9	99
Koepenick, Langlade County..	18	June 3	Sept. 17	106

There are a number of other stations throughout the survey, but weather records have been kept for only a short period of years. From the records available at several of these points the length of growing season appears to be approximately 122 days at Rhineland, 114 days at Minoqua, 107 days at Big St. Germain Dam, and 95 days at Vudesare. Light summer frosts may occur any month during the summer throughout this portion of Wisconsin, especially on low land.

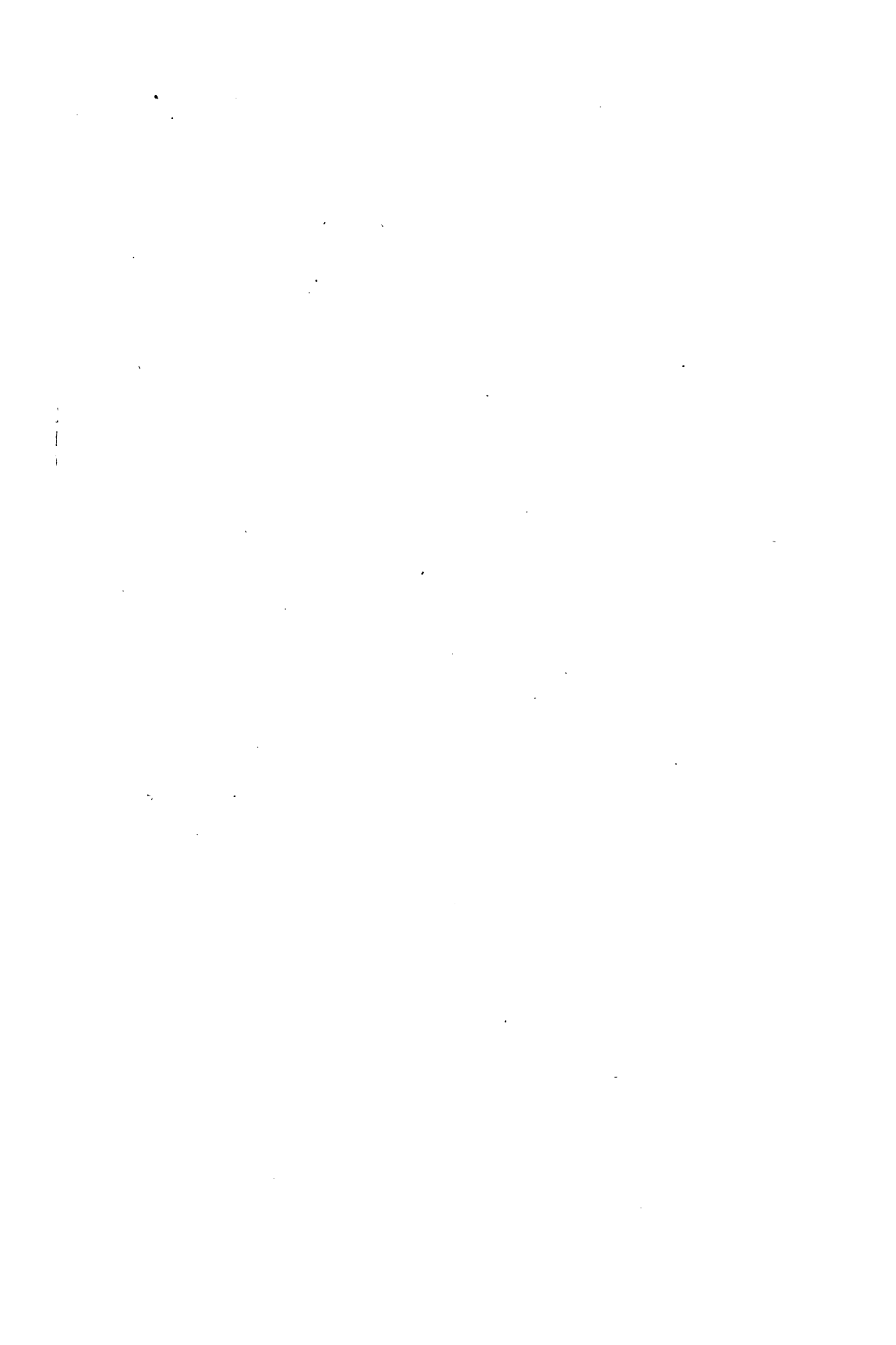
In general it may be said that the climatic conditions prevailing throughout this region are such as to encourage agricultural development. While corn does not mature every year, early varieties can be counted on for good silage. Grasses and clover make an excellent growth, and small grains and potatoes are profitable crops. Dairying and the raising of livestock are industries well adapted to northern Wisconsin. The climate is healthful, and while the winters are long and severe, the summers are especially delightful. The water supply is abundant and of very good quality. On account of the many beautiful lakes in this portion of the state, a large number of people are attracted to this region each year to spend the summer months.

SUMMARY

The area covered by the reconnaissance soil survey of north central Wisconsin includes Vilas, Oneida, Iron, Pierce and parts of Ashland and Rusk Counties. It comprises a total area of approximately 4230 square miles. The surface features are characteristic of a glacial region and the topography varies from level to rolling and hilly. The Penokee Iron Range which crosses the northern part of Iron County is the most conspicuous topographic feature in the area. The highest point on the range has an elevation above sea level of about 1800 feet while Lake Superior, which borders Iron County on the north, has an elevation of 602 feet. Streams within the area afford an excellent opportunity for water power development. The first settlement in the area was made about 1860. The first railroad entered the region in 1877. At present four extensive railway systems traverse the area and provide adequate transportation facilities. The population of the area surveyed was approximately 32,150 in 1910, or about 8 per square mile.

In the area covered by this survey 28 different types of soil were found and mapped. These range in texture from sands of low agricultural value to loams and silt loams of excellent agricultural value. A large proportion of this region is still undeveloped and tracts of considerable extent are still in virgin forest. The greater part of the land is fair to excellent in quality and susceptible of the highest agricultural development. This section is especially well adapted to general farming, dairying and stock raising, and it is along these lines that rapid development is being made.

This region is characterized by a rather short growing season, cold winters, warm summers, and cool summer-nights. Corn does not always mature, but silage of good quality can always be secured. Grasses, clover and small grains do especially well. An abundant supply of water of excellent quality is readily available in all parts of the area, and this region is one noted for its healthfulness.



KEEP THE MAP

The Experiment Station will publish bulletins from time to time dealing with the management of the different types of soil mapped, so that some way should be found by each person receiving a copy of this report to keep the map permanently. If the map is folded in such a way as to have the part you are interested in of a convenient size, and then have a simple frame with glass made to hold it, it can be kept indefinitely. Since some of the colors fade after being exposed to strong light for a long time, it would be a good plan to have a protecting flap of dark cloth over the map when not in use.

**SERIAL-DO NOT REMOVE
FROM BUILDING**

